The Engineer

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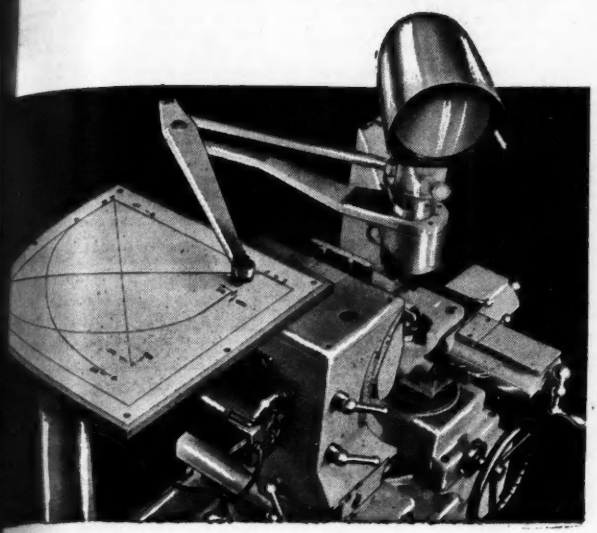

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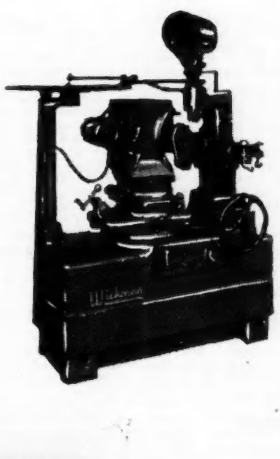

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THE ENGINEER

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NOTICE TO READERS
All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

UNIVERSITY COLLEGE, LONDON

ESSO STUDENTSHIP IN CHEMICAL ENGINEERING

Applications are invited from men with a good University Degree in Chemical or other branch of Engineering or in Chemistry for the ESSO STUDENTSHIP, founded by the Esso Petroleum Co., Ltd., tenable at the Ramsay Memorial Laboratory of Chemical Engineering at the above College from 5th October, 1953. The value of the Studentship is £350 a year, plus College fees.

Applications should be submitted to the Registrar, University College, Gower Street, London, W.C.1, by 15th May, 1953, giving full particulars of educational qualifications, industrial experience (if any), National Service, and outside interests, together with the names of two referees. E8191

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

HEAD OF THE DEPARTMENT OF ENGINEERING

The Governing Body invites applications for the post of HEAD OF THE DEPARTMENT OF ENGINEERING. Duties will commence as soon as possible.

Candidates should possess (a) high academic qualifications, (b) industrial experience, and (c) teaching experience in a Technical College or University. Preference will be given to candidates whose qualifications and experience have been in mechanical engineering. A commencing salary of up to £1340 may be paid to a suitably qualified candidate.

Further particulars and application form will be sent by the undersigned on receipt of a stamped, addressed foolscap envelope. Last date for receipt of applications Monday, 4th May, 1953. Applications not on the form provided will be disregarded.

E. C. SMITH,
Principal.

9th April, 1953. E8197

THE COLLEGE OF AERONAUTICS

DEPARTMENT OF AERODYNAMICS

LECTURER

Applications invited for a post of LECTURER in the Department of Aerodynamics ; this post becomes vacant in August, 1953. The successful applicant will be expected to take an active part in the teaching and research work of the Laboratory, which is well equipped with modern high and low-speed wind tunnels. Salary within the range of £600 to £1000 per annum, with superannuation under F.S.S.U. and family allowance, initial salary depending upon previous experience and qualifications. Small house or single accommodation available.—Applications, giving full particulars and containing names and addresses of not more than three referees, to the Recorder, the College of Aeronautics, Cranfield, Bletchley, Bucks, not later than 8th May, 1953. Further particulars available. E8182

COUNTY BOROUGH OF BARNSLEY EDUCATION COMMITTEE

MINING AND TECHNICAL COLLEGE

Principal : T. LLEWELLYN, B.Sc. (Min.), B.Sc. (Eng.), A.M.I.M.E., F.G.S.

ASSISTANT LECTURER, GRADE B

Applications are invited for the post of ASSISTANT LECTURER, Grade B, in the Department of Mechanical Engineering, to teach mechanical engineering subjects to Higher National Certificate standard and at least one subject to final B.Sc. (Eng.) standard.

Candidates should possess graduate or equivalent qualifications and must have had suitable industrial and teaching experience. Duties to commence as soon as possible. Salary in accordance with the Burnham (Technical) Report, 1951, plus allowances for graduation training and industrial experience.

Forms of application may be obtained from the Principal, Mining and Technical College, Church Street, Barnsley, to whom applications should be returned within two weeks of the appearance of this advertisement.

H. A. REDBURN,
E8160 Director of Education.

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE

TEACHING POSTS

Wandsworth Technical College, TEACHING POSTS, September : (1) Lecturer in Electrical Engineering, to teach electrical technology and electrical power ; a knowledge of electrical installation practice an advantage ; (2) Lecturer in Mechanical Engineering, offering combination of following : strength of materials, metallurgy, theory of structures, theory of machines. Assistants, Grade A, to teach : (3) applied mechanics, engineering drawing, engineering science ; (4) mathematics and engineering science.

Graduate or equivalent qualifications ; teaching and industrial experience desirable. Candidates for posts (1) and (2) will be required to teach to Higher National Certificate level and posts (3) and (4) to at least Ordinary National Certificate level. Salaries : posts (1) and (2), Burnham Lecturer Grade, £940 by £25 to £1040, plus London allowance : posts (3) and (4), varies between £451 and £832, individual minimum and maximum according to age, qualifications and experience.—Application forms from the Secretary, Wandsworth High Street, S.W.18, to be returned by 1st May. (355) E8172

PUBLIC APPOINTMENTS

SOUTH SHIELDS EDUCATION AUTHORITY

MARINE AND TECHNICAL COLLEGE

Principal :
J. HARGREAVES, M.A., Ph.D. (Cantab.)

ENGINEERING DEPARTMENTS

TEACHING POSTS

Applications are invited for the following additional TEACHING POSTS to start on 1st September, 1953 :—

Three Grade A ASSISTANTS and two Grade B ASSISTANTS. Candidates should have qualifications in one or more of the following branches :—Mechanical, marine or electrical engineering, physics, mathematics.

A University Degree or membership of a recognised appropriate professional body, or an equivalent qualification is necessary. Experience as a sea-going engineer would be a strong recommendation for at least one of the posts. The persons appointed will be required to teach their subjects to H.N.C. standard.

Further particulars and application forms may be had by applying to the Director of Education, Education Department, Town Hall, South Shields, stating the post interested in. Completed applications should be sent to the Principal not later than 2nd May, 1953.

A. J. W. JEFFERY,
E8202 Director of Education.

THE COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a RESEARCH FELLOWSHIP which has been established at the College by the English Electric Co., Ltd. The Fellowship is intended to provide opportunity for post-graduate research into problems of vibration or stability and control of aircraft and is tenable for one year, beginning on or about 1st October, 1953. The value of the Fellowship is £500.

Applications, giving full particulars of education and experience and quoting the names of three referees, are required by 1st May, 1953, and should be addressed to the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8181

BOROUGH OF BARNES

APPOINTMENT OF SENIOR ENGINEERING ASSISTANT, GRADE Va

(AMENDED ADVERTISEMENT)

Applications are invited for the above-mentioned appointment on the salary scale £625 by £20 to £685 per annum, plus London weighting allowance.

Preference will be given to applicants who have passed the final examination of the Institution of Civil Engineers or of the Institution of Municipal Engineers and have had several years' experience. Applicants who have partly completed the above examinations will be considered ; but, if appointed, will be placed on a lower grade until the required qualification is obtained.

Applications, giving the names of three persons to whom reference can be made, should be addressed to the undersigned not later than Friday, May 1st, 1953.

The Council is unable to provide housing accommodation.

W. R. SHEPHERD,
A.M.I.C.E., M.I.Mun.E.,
Borough Engineer and Surveyor.

Municipal Offices,
Sheen Lane, S.W.14. E8257

YORKSHIRE OUSE RIVER BOARD

ENGINEER'S DEPARTMENT

APPOINTMENT OF CIVIL ENGINEERING ASSISTANTS

Applications are invited for the above appointments at salaries within A.P.T. Grades V–VII of the National Joint Council for Local Authorities Scheme of Conditions of Service (£595–£785), the point of entry being dependent on qualifications and experience.

Applicants must have passed the examinations of the Institution of Civil Engineers or hold an alternative appropriate qualification, and should have had experience of land drainage and river improvement works.

Conditions of appointment and forms of application may be obtained from the Engineer, Yorkshire Ouse River Board, 21, Park Square South, Leeds, 1.

E. W. WELLS, B.Sc., M.I.C.E.,
E8175 Engineer to the Board.

MINISTRY OF AGRICULTURE AND FISHERIES

DRAINAGE ENGINEERS

Ministry of Agriculture and Fisheries have temporary vacancies for DRAINAGE ENGINEERS (E143/53/A) and ASSISTANT DRAINAGE ENGINEERS (E148/53/A), engaged on land drainage, water supply or coast protection schemes. Starting salary £970 6s. (London) for drainage engineers and between £628 10s. (London, age 25) and £875 10s. (London, age 34 and over) for assistant drainage engineers. Provincial and women's salaries somewhat lower.

Candidates must be Corporate Members of Institution of Civil Engineers.

Application forms from M.I.N.S., Almack House, 26, King Street, London, S.W.1, quoting appropriate reference number. E8240

PUBLIC APPOINTMENTS

AIR MINISTRY

ROYAL AIR FORCE TECHNICAL CADETSHIPS

Young men between 17 and 19½ years on 1st July, 1953, are invited to apply for TECHNICAL CADETSHIPS leading to Permanent Commissions in the Technical Branch of the Royal Air Force and offering excellent prospects of promotion to higher rank.

There are two kinds of Technical Cadetships as shown below.

University Cadetships : candidates must be educationally qualified for University entrance and possess a General Certificate of Education with passes at Advanced Level in Physics and Mathematics, or a Scottish Leaving Certificate with Higher Grade Passes in these subjects, or have an equivalent qualification. Successful candidates are first given a year's preparatory training as Officer Cadets at the R.A.F. Technical College, Henlow. They are then commissioned and are sent to a University for a three years' Honours Degree course in Science or Engineering. Provided they are medically fit they learn to fly with the University Air Squadron. Pay during training starts at 7s. per day. During the University Course the Service pays all fees as well as board and lodging allowances, and at the same time pay is increased to 12s. a day, rising to 17s. 6d. On graduation, cadets become Permanent Officers of the Technical Branch and will have opportunities of rising to air rank, at which basic salaries range from £1551 to £2738 a year. On retirement they will qualify for a terminal grant of £1000 and retired pay.

Henlow Cadetships : candidates must possess a General Certificate of Education with passes at Ordinary Level in English Language and two other subjects, and also passes at Advanced Level in Physics and Mathematics, or an equivalent Scottish Leaving Certificate or other equivalent qualification. Successful applicants will spend three years as Officer Cadets at R.A.F. Technical College, Henlow, where they will be trained in Mechanical or Electrical Engineering to the standard of the Higher National Certificate. During this training pay rises from 7s. to 9s. 6d. a day, food, lodging, &c., being provided. On successful completion of the Henlow course cadets become Permanent Officers of the Technical Branch with career prospects similar to those of University Cadets. Entries for Cadetships under both schemes close on 1st June, 1953.—For further particulars write to Air Ministry, A.R.1 (J.4), Adastral House, Kingsway, W.C.2. E8212

CHELSEA GROUP HOSPITAL MANAGEMENT COMMITTEE

GROUP ENGINEER

Chelsea Group Hospital Management Committee (6 establishments), GROUP ENGINEER required, non-resident, but the officer appointed will be required to reside within a reasonable distance of the Group. Applicants should be mechanically trained, served an apprenticeship in mechanical engineering or acquired a suitable practical training. Applicants not already in the Health Service should hold an engineering qualification up to the standard of the Higher National Certificate. Salary £630 by £20 to £730, plus £30 London weighting (20)–30 pointage).—Apply immediately for application forms to the Secretary, St. Luke's Hospital, Sydney Street, Chelsea, S.W.3 (enclose S.A.E. foolscap). E8229

MINISTRY OF SUPPLY

ENGINEER

Ministry of Supply require ENGINEER, London, assist plan production, progress wide range Army radar, signals equipt. Qualifications: recognised eng. apprenticeship and A.M.I.C.E. or Mech.E. or Elec.E. or exempting qualns. Sound knowledge electronic equip., experience modern prodn. methods essential. Able assess prodn. capacity, deal with executives, business and Departmental. Experience radar equipt., servo mechanisms, centrimetric wavelength technique advantageous. Salary £628 (at age 25) to £970. Appointment temporary, but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, S.W.1, quoting D 130/53A. Closing date 8th May, 1953. E8184

SOUTHAMPTON CORPORATION WATERWORKS

TWO ASSISTANT ENGINEERS REQUIRED

One, salary A.P.T. VIII (£760–£835), age 33 to 40 years. Must be experienced in design, construction, operation and maintenance of works of water supply.

One, salary A.P.T. V (£595–£645), age not exceeding 35 years. Some experience in waterworks essential.

Both must be Corporate Members of Institution of Civil Engineers. Conditions of appointment from, and application to, Joseph Hawksley, M.I.C.E., Waterworks Engineer and Manager, Civic Centre, Southampton, by noon Monday, 11th May, 1953. E8210

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION

ASSISTANT METALLURGIST

The Parsons and Marine Engineering Turbine Research and Development Association requires an ASSISTANT METALLURGIST for work in connection with steam and gas turbine development. Previous experience in a metallurgical research or development laboratory and knowledge of the metallography and creep properties of ferritic and austenitic steels is desirable. A good salary will be paid, depending on age, experience and qualifications.—Apply in writing to the Research Director, Pametrada Research Station, Wallsend. E8180

PUBLIC APPOINTMENTS

RHODESIA RAILWAYS

CHIEF ENGINEER'S DEPARTMENT

VACANCIES FOR CIVIL ENGINEERS

Vacancies exist for fully qualified CIVIL ENGINEERS for service in the Chief Engineer's Department of the Rhodesia Railways. Preference will be given to men under the age of 25 years will be considered, but married men not exceeding 30 years of age will be considered.

A Degree in Civil Engineering and/or Graduate Membership of the Institution of Civil Engineers is essential.

The grades of Junior and Assistant Engineer carry salary scales between the limits of £560 and £1750 per annum, with incremental notches of £60 per annum, and the commencing salary would be determined in accordance with age and experience.

The vacancies are for appointment to the permanent staff in the first instance, but transfer to the temporary staff may be made to fill vacancies and on the recommendation of the Chief Engineer.

Vacancies may occur later on for members of the permanent staff for the grade of District Engineer by selection within the scale £1350 to £1750 per annum.

All salaries are enhanced by a variable cost of living allowance, which at present is 18 per cent. of basic rates.

Full particulars may be obtained from the Crown Agent, Rhodesia Railways, 241, Salisbury House, London Wall, London, E.C.2.

Applications should reach the London Agents by the 30th April, 1953.

CIVIL SERVICE COMMISSION

GOVERNMENT DEPARTMENTS

PROFESSIONAL ENGINEERS

PROFESSIONAL ENGINEERS in Government Departments. The Civil Service Commissioners invite applications for about 150 permanent posts in a wide variety of mechanical and electrical engineering duties. Applications will be accepted up to 30th September, 1953, but an earlier closing date may be announced.

Candidates must be under 35 on 1st January, 1953, with extension for regular service in H.M. Forces and up to two years for permanent civil employment. For the Post Office they must be at least 21 and under 28 ; Ministry of Supply and Ministry of Civil Aviation, at least 23, and for all other Departments at least 21 on that date.

Generally, a candidate must possess a University Degree in Engineering or be a Corporate Member of one of the professional Institutions—Mechanical Engineers, Electrical Engineers, or Civil Engineers—or have passes in, or exemption from, Sections A and B of the corresponding Associate Membership examinations. Exceptionally candidates of high professional attainment, but without the specified qualifications, may be admitted. For some posts Associateship of the Royal Aeronautical Society or an Honours Degree in Physics will be accepted.

Inclusive salary scale (men in London) £415 (at age 25) to £970. Starting salary according to age up to £875 at 34. Candidates entering below age 25 start at salaries varying from £429 at age 21 to £815 at age 24. Prospects of promotion. Salaries for higher grades are £970–£1280 and £1350. Somewhat lower for women and in the Provinces.

Further particulars and application forms from Civil Service Commission, Scientific Branch, Burlington House, Old Burlington Street, London, W.1, quoting No. S85/53.

MINISTRY OF SUPPLY

DIVISION OF ATOMIC ENERGY (PRODUCTION)

ENGINEERS

ENGINEERS required by Division of Atomic Energy (Production) for (a) capital expenditure estimating for major projects, including budget preparation and cost control. Work involves giving approximate estimates from outlined information, then later accurately estimating from more detailed information.

(b) Collaboration with design engineers in preparation of specifications for all types of special plant and equipment for large factories. Duties include preparation of manufacturing capacity and supply information for contracts. Up-to-date knowledge of engineering markets essential.

(c) Progressing of work through contractors' shops and assisting with production capacity and production difficulties in order to maintain construction programmes.

Qualifications for above posts : recognised engineering apprenticeship and A.M.I.Mech.E. or equivalent ; shop experience in engineering production with extensive experience in one or more fields mentioned essential. Salary £927 to £1280. Voluntary superannuation. Houses within reasonable time, if married.—Applications to Ministry of Supply, D.At.En. (P), Risley, Warrington, Lancs. 452.

ADMIRALTY

CIVIL ENGINEER-IN-CHIEF'S DEPARTMENT

CIVIL ENGINEERS (MAIN GRADE)

Vacancies exist for CIVIL ENGINEERS (Main Grade) in the Civil Engineer-in-Chief's Department, Pinner, Middlesex. Starting salary £950 per annum. Duties cover headquarters administration and engineering programme. Temporary appointments. Minimum age 40. Applicants must be natural born British subjects and Corporate Members of the Institution of Civil Engineers. Admin. experience essential.—Application forms, quoting E1 (K), from M.L.N.S., Technical and Scientific Register (K), Almack House, 26, King Street, London

THE ENGINEER

APRIL 17, 1953

The Budget

LAST Tuesday afternoon the Chancellor of the Exchequer, Mr. R. A. Butler, presented his Budget in the House of Commons. In the course of his statement, the Chancellor recalled that the last budget had been designed primarily to rectify the adverse balance of payments, and the measure of success could be judged by the figures. The United Kingdom balance of payments on current account had changed from a deficit of £398 million in 1951 to a surplus of £291 million in 1952. But, the Chancellor added, that progress must be kept up. The Chancellor went on to say that for the first time since the war a "step in a new direction" was being taken, and he proposed no new taxes at all. The reliefs which he proposed were designed to improve the nation's competitive efficiency, to provide incentives for greater effort, and to encourage private saving. The main proposals were to reduce all rates of income tax by sixpence in the pound, bringing the standard rate to 9s.; a general reduction of one-quarter on all degrees of purchase tax; a reduction from 25s. to 10s. in the additional duty on light motor-cycles with sidecars; the ending of the excess profits levy from January 1, 1954; and the immediate resumption of initial allowances for capital expenditure on plant and machinery, industrial buildings and new mining works. About this last-mentioned proposal the Chancellor said that the initial allowances would operate for profits tax as well as income tax. The rate for plant and machinery, including agricultural machinery, would be 20 per cent; for capital expenditure on the construction of industrial buildings the rate would be 10 per cent; and for capital expenditure, both at home and oversea, on new mining works the rate of initial allowance would be at 40 per cent instead of the 10 per cent formerly granted. The estimated cost of all the tax reliefs proposed in the Budget this year is £169 million, and the Chancellor's expectation is that there will be a surplus of revenue over expenditure of about £109 million.

Tees-Side Steel Works Development

THIS week some particulars have been announced of the third stage of the steel works development plan which is being carried through by Dorman, Long and Co., Ltd., of Middlesbrough. The first stage of this plan included the ore unloading, ore preparation and sinter plants at the Cleveland iron and steel works, and the second stage, which is now approaching completion, comprises the basic open-hearth steel plant at Lackenby, which will have an annual ingot output of 500,000 tons. It includes also considerable site preparation work for the third stage of the plan. The capital expenditure incurred by the first two stages is put at approximately £14,000,000, and the third stage will involve expenditure of about £36,000,000. The company says that the largest item in this final stage of its development programme is the installation at Lackenby of a universal beam and heavy section mill with an annual output of 400,000 tons of rolled products. Facilities for rolling ordinary standard structural sections will be incorporated in this beam and section mill. A fifth steel furnace is to be added to the Lackenby melting shop, which will bring the annual output of the new works up to 625,000 tons of ingots. Two other schemes included in the third stage are the construction of two blast-furnaces, of 27ft 6in hearth diameter, with a joint capacity of 750,000 tons of pig iron a year, and a new coke oven plant at the Cleveland works to carbonise 1,300,000 tons of coal annually. The Clarence works are to be enlarged to process the extra tar and benzole. In addition a new blooming mill and a new medium section mill are to be installed at the Cleveland works and an existing blooming mill is to be extended. A high capacity rod and bar mill, with an annual capacity of 175,000 tons and expanded capacity for wire production and processing are also to be laid down. It is expected that the completion of these various projects in the third stage of the development programme may take up to five years.

The Status of the Engineering Profession

THE attitude which parents and schools still harboured as to the worthiness of engineering as a career and its influence on recruitment to that profession were the main themes in an address by Lord Hives at the University of Nottingham when opening the extensions to the engineering laboratories last Tuesday. Lord Hives remarked that it was well that many more students now had the opportunity of entering a university. But as this country was becoming increasingly more dependent on achievements in applied science was it not disturbing, he wondered, that of 72·5 per cent of the students receiving some form of State aid only 12·4 per cent were studying technology. In examining this situation, which Lord Hives stated was causing much concern to both educationalists and industrialists, he believed that its cause did not resolve upon training facilities or lie even at university level. It had a much deeper root, he continued, for it rested in the attitude of mind held by the parents and of the schools. Engineering fundamentals were not taught at schools and consequently a pupil was advised on his career by information supplied by his career master and head master, information, Lord Hives added, which was often sadly lacking. He referred to a statement made by Professor Kastner of Swansea University College, which maintained that careers masters in schools were so often ill-informed as to the opportunities in engineering to-day. Only too often, Lord Hives continued, did a boy choose for his career something right outside industry or entered the field of pure science. Even when a careers master was impressed with the industrial prospects there remained the task of convincing the parents and the boys, for, Lord Hives insisted, there still survived the view that a career in industry was not so respectable as one in the services or professions. That attitude, he claimed, was not only out of date but harmful if this country was to remain a great power. Lord Hives went on to say that he did not think we should copy American industrial training systems. What we did need to do was to reflect upon the high position in society which the Americans gave to industry and by which it attracted the best brains. There was no better training for an executive in industry to-day than once to have worked as a skilled engineer. Yet to many people, Lord Hives stated, engineering was still something "messy"; something that polite young men ought not to get mixed up in!

The British Electrical and Allied Manufacturers' Association

THE forty-second annual report of the British Electrical and Allied Manufacturers' Association (BEAMA) for the year 1952–53 was presented at the annual general meeting of the Association yesterday. The report gives some details of the continued expansion of the electrical manufacturing industry. There was a record installation of generating plant for the British Electricity Authority of 1540MW, compared with 1235MW a year previously. The amount of generating plant exported, 900MW, was also a record. With a total of £218 million worth of direct exports (15 per cent more than in 1951) the electrical manufacturing industry again became the second largest exporting industry in the United Kingdom. This expansion was mainly attributable to an increase of about £10·5 million in the exports of electrical machinery and an increase of about £8·5 million in shipments of electric wire and cables. Australia, South Africa and India were again the largest buyers of British electrical goods and the growth of the Canadian market was well maintained: Canada, in fact, was second only to Australia as a buyer of British generating plant. The BEAMA report gives some details of Germany's recovery as an electrical exporter, thanks mainly to the fact that "she is able to offer shorter deliveries and more favourable terms of payment." According to the report Germany's exports advanced by 59 per cent from £56·3 million in 1951 to £89 million in 1952. Japan's influence as a competitor in the field of electrical export was mainly felt in India and Pakistan. Shipments of electrical goods from Japan totalled £8·6 million in 1952, compared with £5·4 million in 1951. The report gives a survey of the work of the sections and of the BEAMA Council and technical committees. The membership of BEAMA was 387, an increase of seven compared with 1951–52.

Association of Supervising Electrical Engineers

AT the annual dinner of the Association of Supervising Electrical Engineers, which was held in London on Friday, April 10th, the toast of the Electrical Industry was proposed by Sir David Brunt, chairman of the Electricity Supply Research Council of the British Electricity Authority. Sir David spoke of the present as an age of domination by committees. As a secretary of the Royal Society he was concerned with no less than fifty committees. He thought the time had been reached when subservience to the principle of progress by committee could be regarded as the menace of the age. Mr. T. G. N. Haldane, immediate past-president of the Association, responding to the toast, said that the time was ripe for a dispassionate assessment to be made of national ownership of the electricity supply industry: it might be thought that this regime represented a fair compromise between the needs of the individual and of the community. Speaking of the problems of training, Mr. Haldane mentioned the urgent need to cater for the important class that lay somewhere between the skilled craftsman and the professional engineer, particularly in the field of utilisation. It was one of the tasks of the A.S.E.E. to cater for this class of engineer. The toast of "the guests" was proposed by Mr. C. T. Melling, president of the Association, and the response was made by Mr. T. E. Goldup, director of Mullard, Ltd.

The Central Line Accident

ON the evening of Wednesday, April 8th, nine passengers lost their lives and seven were seriously injured in a collision on the Central Line of London Transport. The accident occurred in the eastbound tube tunnel a short distance east of Stratford station, at 6.56 p.m., when a train bound for Epping ran into the rear of a stationary train bound for Hainault. Both trains were well loaded with passengers and it was in the first two coaches of the Epping train, which were severely damaged as a result of the collision, that most of the casualties occurred. The confined conditions and extent of the damage made the work of the rescuers particularly difficult, and it was not until Thursday morning that all the injured had been removed and the bodies had been recovered. All the debris had been cleared on the line by the morning of Friday, April 10th, when full normal services were resumed at 10 a.m.

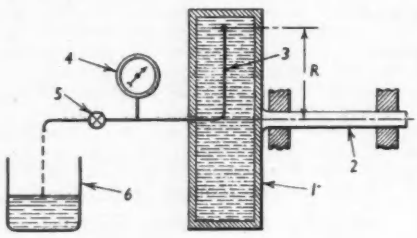
High-Pressure Pumps

By U. M. BARSKE

Two kinds of single-stage, high-pressure centrifugal pumps are dealt with. The fundamental ideas common to both, their designs and operational properties are briefly described. The ideas explained were originally put forward by the author in 1937 in the development section of Messrs. Henschel und Sohn at Kassel, Germany and, thanks to the positive reaction of those concerned with these suggestions, an interesting and successful development of different types of high-pressure centrifugal pumps was started.[1,2] *This development work has continued in this country for several years under the sponsorship of the Ministry of Supply, and arrangements have been made which will allow thorough investigations of the hydrodynamic problems involved in the new pump design.*

The Hollow Impeller Pump

Diagrammatic Arrangement.—Referring to Fig. 1, which diagrammatically shows a closed cylindrical vessel 1 completely filled with a liquid and rotating about its longitudinal axis (shaft 2) at a constant angular velocity ω, the total liquid pressure measured



1. Rotating vessel.
2. Shaft.
3. Pitot tube.
4. Pressure gauge.
5. Discharge valve.
6. Tank.

Fig. 1—Diagram of Hollow Impeller Pump

with a Pitot tube 3 at a distance R from the axis is given by the well-known equation :

$$p=\frac{\rho}{g}\omega^2R^2=\frac{\rho}{g}u^2 \text{ (lbs/ft}^2\text{)} \quad . \quad . \quad (1)$$

where ρ is the density of the liquid (pounds per foot^3)
g is the gravity acceleration (feet per second^2)
u is the peripheral velocity (feet per second) of the liquid at a distance R (feet) from the axis.

The gravity head of the liquid is supposed to be negligibly low compared with the centrifugal pressure. Another well-known fact is that the total pressure p consists of two equal components, the static pressure p_s and the dynamic pressure p_d, the latter being the equivalent of the kinetic energy of the liquid converted into static pressure by ram effect at the orifice of the Pitot tube.

Though the liquid is moving at a high absolute velocity this pressure generation cannot be looked upon as a hydrodynamic process as there is no flow relative to the vessel. Ignoring the low energy required to overcome bearing and air friction, it can be stated that this method of generating fluid pressure does not involve any losses, i.e. the efficiency is 100 per cent.

Another important feature is that no high pressure seal is needed, the pressure difference across the central hole through which the Pitot tube extends outwards being negligibly low.

When opening the valve 5 (Fig. 1) to a very small extent some liquid will be discharged into the tank 6, and in order to keep the rotary vessel filled the same small quantity of liquid has to be replaced in a suitable way through the central orifice. The pressure indicated by the gauge 4 will be very nearly the same as before as long as the flow velocity inside the Pitot tube is very low.

The device is acting now as a pump delivering a low flow against a high pressure, with low internal losses.

Example of a Hollow Impeller Pump[3].—A real pump the design of which is based on the above principles, is shown in Fig. 2. The rotary vessel 1 may be called now the hollow pump impeller, which is provided with some radial ribs 2 in order to ensure transmission of the rotation to the liquid. The Pitot tube has changed into the streamlined scoop wing 3, which may be doubled in order to increase the flow. The inner passage 4 of the scoop wing is shaped as a diffuser to enable a certain percentage of the kinetic energy of the liquid entering the intake orifice 5 to be converted into static pressure. A central air bleed not shown in the drawing is often important for a safe priming (complete filling) of the pump.

The energy losses in the rotating liquid caused by the static scoop wings 3 are no longer negligible, of course, but they can be kept within reasonable limits by a streamlined shape and a good surface finish of the scoop wings. Also a certain axial length of the hollow impeller relative to the width of the scoop wing is essential, mainly in the zone of high peripheral velocities. Therefore, the impeller 1 is wider at the periphery

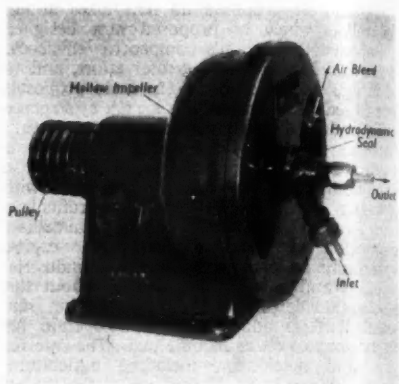


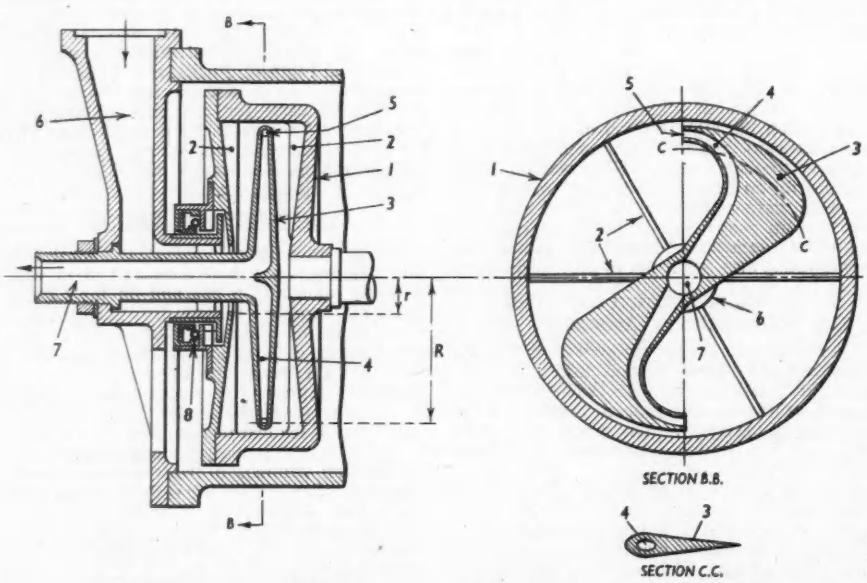
Fig. 3—A Typical Hollow Impeller Pump

than at the centre. This shape of the hollow impeller is also favourable with respect of its end walls, and it allows the shaft bearing (not shown) to be brought nearer to the centre of gravity of the impeller; it also allows more space for the sealing device.

A V-belt driven fuel pump of the hollow impeller type is shown in Fig. 3. At 5000 r.p.m. it delivers 6 gallons per minute against a pressure of 450 lb per square inch.

The Entry Seal.—Though the entry seal, as stated above, is under inlet pressure only, it proved difficult in practice to get conventional mechanical seals (bellows glands) operating satisfactorily. Also the axial space needed for this type of seal was inconvenient. Considerable thought was given, therefore, to a simple solution of this problem, and the outcome was the "hydrodynamic seal" incorporated in the pump (Fig. 2) and shown in a larger scale in Fig. 4.

The seal consists of a rotary chamber formed by a seal ring 1 which is fixed to the hollow impeller 2. The chamber is divided into two sections by a static flange 3 fixed to the inlet pipe 4. Static radial blades 5 integral with the flange 3 extend into the inner section of the chamber, in order to prevent rotation of the liquid filling this space. Another set of radial blades 6 extending into the outer section of the chamber are part of the seal ring 1 and force the liquid in this section to rotate. In operating conditions a free liquid level 7 shown on the lower half of the drawing is automatically formed so that the pump inlet pressure, which is supposed to be above atmospheric, is

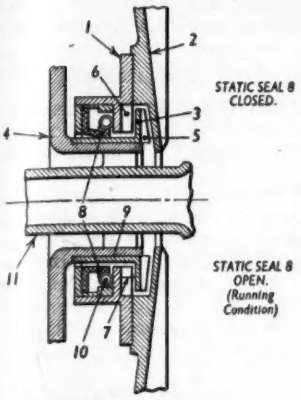


1. Hollow impeller.
2. Radial ribs.
3. Scoop wing.
4. Diffuser.
5. Intake orifice.
6. Pump inlet.
7. Pump outlet.
8. Inlet seal.

Fig. 2—Hollow Impeller Pump

balanced by the centrifugal pressure generated in this space.

Under low speed and static conditions, leakage is prevented by the "static seal," which is very similar to a standard oil seal, the main difference being that the seal is attached to the rotary members, in this case to the seal ring 1. As also shown in the lower half of Fig. 4, the flexible sealing ring 8 is, in running conditions, expanded by



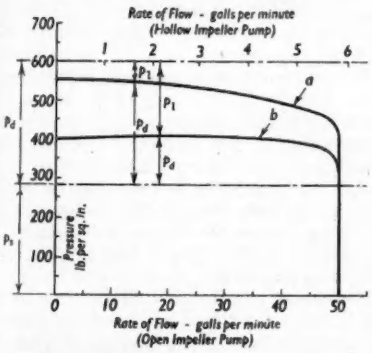
1. Seal ring.
2. Wall of hollow impeller.
3. Static flange.
4. Pump inlet.
5. Static vanes.
6. Rotary vanes.
7. Liquid level in running conditions
8. Flexible sealing ring (static seal).
9. Static sealing face.
10. Garter spring.
11. Discharge passage of pump.

Fig. 4—Inlet Seal

centrifugal force and breaks contact with the static sealing face 9. Below a certain shaft speed the sealing ring 8 closes the gap by its own resilience assisted by that of the garter spring 10.

This hydrodynamic seal meets the requirements of high speed pumps in an almost ideal way. It is absolutely safe, the frictional losses are generally negligible, the design is simple, rough tolerances can be applied to its manufacture, and only the static sealing ring is subjected to some little wear.

The seal can easily be adapted to negative leakage pressure, i.e. a pump inlet pressure below atmospheric, and also to positive and



Curve *a*. Hollow impeller pump.
Curve *b*. Open impeller pump, equal peripheral velocities $R.\omega$ for both pumps.
Static pressure, $p_s = \rho\ \omega^2\ (R^2 - r^2)/2_g$.
Theoretical dynamic pressure, $P'_d = \rho\ \omega^2 R^2/2_g$.
p_d = virtual dynamic pressure.
p_l = pressure losses.

Fig. 5—Characteristic Curves Compared

negative leakage pressures occurring alternately during operation.

Comparison with Centrifugal Pump.—When comparing the hollow impeller pump with conventional centrifugal pumps it is important to note that :—

(*a*) In principle, the inside surfaces of the hollow impeller do not require any machining because the relative liquid velocities are low throughout.

(*b*) The shape of the internal ribs or blades is unimportant as their purpose is merely to keep the liquid in rotation.

(*c*) No narrow clearances exist in the pump, including the seal, and no precision work is needed in manufacture ; in operating conditions no solid members are in contact with each other.

(*d*) The pump will operate equally well at different flow rates while running at constant speed because shaped vanes with entry and exit angles designed for one special flow rate only are not needed.

(*e*) Very high pressures can be generated in one single stage because there is no high pressure sealing problem, neither externally nor internally.

(*f*) All hydraulic forces are axially balanced and the impeller is not subjected to any end thrust.

When primed at the start, the pump is capable of operating at low absolute inlet pressures, i.e. high suction lifts can be handled.

No signs of cavitation have ever been found in these pumps.

Hydraulic Performance Data.—Fig. 5 shows a typical curve of the delivery pressure measured outside the pump (Fig. 1) and plotted against flow rate at a constant shaft speed. In a practical design of pump, as distinct from the diagrammatic device shown in Fig. 1, the central portion of the liquid in the hollow impeller does not rotate and, with reference to Fig. 2, the static pressure is:

$$p_s = \frac{\rho}{2g}\,\omega^2\,(R^2 - r^2) \quad . \quad . \quad . \quad (2)$$

The dynamic pressure is developed to its full extent and according to equation (1) :

$$p_d = \frac{\rho}{2g}\,\omega^2 R^2 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The scoop wing acting essentially like a Pitot tube converts nearly the whole kinetic energy into static pressure at zero flow, but with increasing flow the pressure decreases owing to energy losses in the internal passages (diffuser, pressure pipe).

When the full energy imparted to the liquid is converted into velocity in the scoop wing entrance (diffuser throat) the maximum possible flow for this particular shaft speed is attained and the curve drops suddenly.

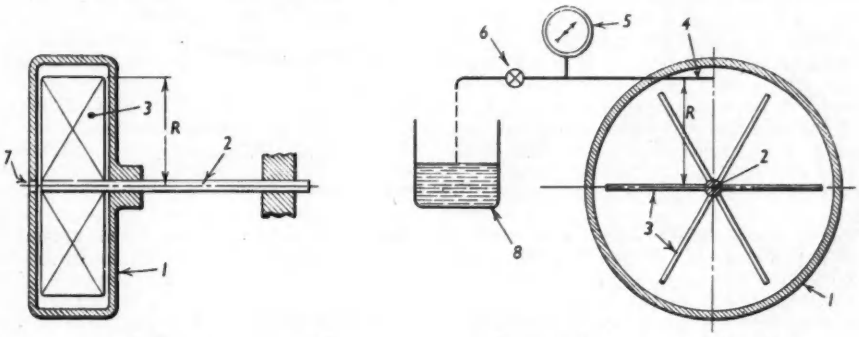
Hollow impeller pumps have been operated at peripheral velocities up to 300ft per second, the corresponding pressures being above 1000 lb per square inch. The pressure which can be generated in these pumps is normally limited to about 1500 lb per square inch, this limit being imposed by the allowable maximum stress in the material of the impeller, which is subjected to both the liquid pressure and its own centrifugal forces. Special materials and special designs of the impeller will allow still higher pressures.

The capacities range from any small quantity to approximately 50 gallons per minute. The efficiencies at low flow rates are necessarily low but this is of less importance if the absolute powers are low and if simplicity and safety of operation predominate. At higher flow rates efficiencies can be between 40 and 50 per cent.

The Open Impeller Pump

Diagrammatic Arrangement.—Contrary to Fig. 1, it may be desirable in certain cases not to have the vessel rotating with the liquid but to rotate only the liquid inside the static vessel. Then, as shown in Fig. 6, a rotary shaft 2 has to pass through a central hole in one of the end walls of the static vessel 1, the rotation of the shaft being transferred to the liquid by radial blades 3, fixed to the shaft.

A Pitot tube 4 for measuring the full pressure can be fixed immediately to the cylindrical wall of the vessel and if the orifice of the Pitot tube is very close to the tip circle of the blades 3 (radius *R*) the full pressure indicated by the gauge 5 is obviously the same as obtained in the device shown in Fig. 1, and as given by equation (1). How-



1. Stationary vessel.
2. Shaft.
3. Blades.
4. Pitot tube.
5. Pressure gauge.
6. Discharge valve.
7. Feeding orifice.
8. Tank.

Fig. 6—Diagram of Open Impeller Pump

ever, the difference between the two arrangements is that in Fig. 6 a certain amount of skin friction of the rotating liquid against the stationary casing 1 has to be overcome, whereas in the hollow impeller pump only the Pitot wing is subject to skin friction ; thus greater energy losses are necessarily involved in this method of generating fluid pressure as the casing presents a greater surface area than the Pitot wing. No relative velocity exists between the liquid and the impeller blades 3, assuming that the whole liquid rotates at the constant angular velocity ω.

In the same way as before (Fig. 1), the device shown in Fig. 6 can be made to operate as a pump by slightly opening the discharge valve 6 and by replacing, at the same time, through a central inlet port 7, the liquid discharged.

Example of an Open Impeller Pump.—The paddle-wheel diagrammatically shown in Fig. 6 represents an unshrouded or open pump impeller of the simplest kiud and a pump designed on the lines indicated by this diagram has to be provided with a casing which, on one hand, allows for a low radial liquid velocity at full flow. On the other hand the frictional surface has to be reduced as far as possible and, therefore, the axial width of the casing 1 shown in Fig. 7 is smaller at the periphery than at

the centre. It may be pointed out, however, that the most efficient way of reducing the surface area and, consequently, the friction losses, is to increase the angular velocity of the impeller as far as practicable.

Transposing equation (1) :—

$$R=\frac{1}{\omega}\sqrt{\frac{p.g}{\rho}} \quad . \quad . \quad . \quad (4)$$

it can be seen that a higher angular velocity, or shaft speed, respectively, enables a given pressure to be generated with a smaller impeller. This reduction of the impeller radius means a considerable decrease in friction losses, which, as is well-known, are proportional to approximately the fifth power of the radius but only to approximately the third power of the angular velocity.

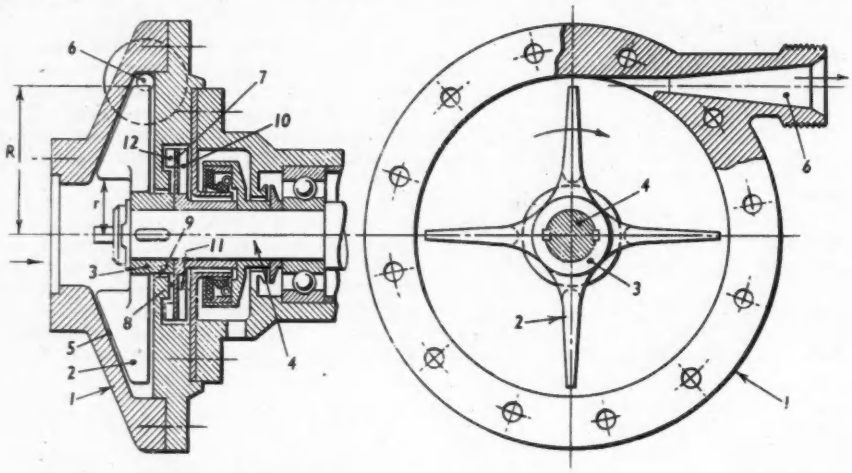


Fig. 7—Open Impeller Pump

Strong radial blades 2, the number of which varies from three to six, are integral with the hub 3 of the impeller, which is fixed to or, if required, integral with the shaft 4.

An important point with regard to cheap manufacture and safe operation of the pump is that ample axial clearances 5 (0·02in to 0·03in on each side) can be allowed between the impeller blades and the pump casing without affecting the pump efficiency. The tangential Pitot tube shown in Fig. 6 has been converted into a diffuser 6, the centre line of which is approximately tangential to the tip circle of the impeller blades 2.

Shaft Seal.—The shaft seal, like the inlet seal of the hollow impeller pump, operates under inlet pressure only. The type of hydrodynamic seal shown in Fig. 7 has proved to be the most suitable arrangement for high shaft speeds. The sealing impeller 7, which may be described as "open," also rotates in a chamber 8, communicating with the interior of the pump casing 1 through the gap 9. The impeller consists of a circular disc 7 provided on its outer face with radial blades 10, which, in operating conditions, generate a centrifugal pressure to balance a positive pump inlet pressure, the level 11 of the rotating liquid settling as shown on the lower half of Fig. 7. This special design also meets the requirements of a pump the inlet pressure of which may fall below ambient pressure during operation. Then the liquid level 11 moves nearer to the periphery so that the shorter blades 12 on the inner face of the sealing impeller come into action by building up a centrifugal pressure to balance atmospheric pressure.

This seal, therefore, automatically handles positive and negative inlet pressures, thus safely preventing any air from entering the pump.

The static seal is of the same design as shown in Fig. 4. New combinations of hydrodynamic seals and simpler static seals requiring less axial space have been developed recently in this country.[4]

Comparison with Centrifugal Pump.—As the open impeller pump is based on the same hydrodynamic principles as the hollow impeller pump, the properties of the latter stated above are common to both types. Obviously, the statement (*a*) now applies to the open impeller and (*b*) to the impeller blades. The items (*c*) to (*f*), however, can be related literally to the open impeller pump.

A special advantage with regard to high speed operation is the small mass of the open impeller, which permits a fair amount of overhang of the pump shaft without much risk of vibration. The manufacture of the pump is even easier and the overall weight and dimensions smaller than those of the hollow impeller type.

Hydraulic Performance Data.—With regard to the delivery pressure equations (2) and (3) are applicable to the calculation of the components p_s and p_d, respectively, but in practice a lower percentage of the kinetic energy is converted into static pressure than in the hollow impeller pump. This is clearly indicated by the characteristic curve "*b*," Fig. 5, which, though related to the same peripheral velocity, is considerably below the curve "*a*." This is mainly due to the less favourable entrance conditions at the diffuser inlet, the flow being much more effected by flow breakaway than at the intake orifice of the scoop wing in the hollow impeller pump. A remarkable fact is that the delivery pressure remains approximately constant for all rates of flow until, near maximum flow, the curve drops down for the same reason as that applicable to the hollow impeller design. In practice, pressures up to 1500 lb per square inch have been generated in single-stage pumps of this type.

The shaft speeds range from approximately 10,000 to 50,000 r.p.m. and the impeller diameters from approximately 6in to less than 1in, the smaller diameters being associated with the higher speeds and higher pressures. The maximum volume flow used so far amounts to approximately 150 gallons per minute and efficiency can exceed 50 per cent at higher flow rates.

With a properly designed inlet the radial-bladed open impeller is remarkably well capable of handling liquids near to boiling conditions and no serious trouble by cavitation has been experienced under such operational circumstances, though the entrance tip velocities of the blades are usually higher than in normal pump practice.

A casing and a five-bladed impeller of a twin-diffuser open impeller pump are shown in Fig. 8.

Conclusions

The two pump designs described above have a very different appearance but it will be clear that they are based on the same idea.

In both designs the pump casings may be considered as pressure reservoirs, the pressure being generated by spinning the liquid in some suitable way. The maximum quantity of liquid tapped from the reservoir is relatively small so that flow velocities of negligible magnitude are obtaining therein.

The favourable properties of both designs are basically the same. With regard to optimum efficiencies the operational shaft speed should be as high as mechanically

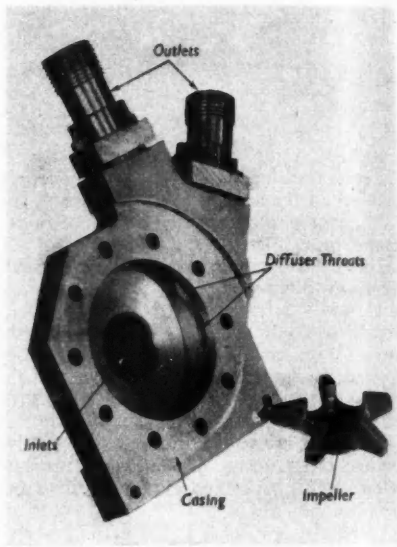


Fig. 8—Parts of Twin Diffuser Open Impeller Pump

practicable and, therefore, the pumps are most suitable for coupling directly with high-speed turbines. Under certain conditions the hollow impeller pump enables a separate turbine rotor to be dispensed with by fixing the turbine blades immediately to the periphery of, or to, a disc integral with the pump impeller.

Because of its lower fluid friction losses, the hollow impeller pump is more suitable for very low flow rates, say, up to approximately 10 gallons per minute. Above this limit, which is, however, a very flexible one, the whole layout sometimes becomes less favourable and the rotating mass of the liquid filled impeller may be larger than desirable in many applications.

The geometrical design of the open impeller pump is better adaptable to higher rates of flow because it is easier to increase the size and the number of diffusers. Further, the discharge passage need not be arranged in the centre of the pump, in addition to the inlet duct. The higher fluid friction losses are tolerable in connection with higher capacities. Due to its outstanding simplicity and the very small rotating mass of

the open impeller, this form has been used frequently for very low flow rates, although a hollow impeller pump would have given a better efficiency.

The simple design, the great safety in operation as well as the very small dimensions and low weights obtained by introducing high shaft speeds, have made these pumps attractive for applications in which these virtues are urgently needed. Further improvements can be expected but even the results achieved so far may justify the suggestion that the use of similar pumps should seriously be considered for a number of existing purposes where multi-staged pumps are used, as any saving in manufacturing costs and materials will help to overcome the present economic difficulties.

REFERENCES

[1] German Patent Specification No. 684,207, "Rotary Pump, Especially for High Pressures" (issued November 24, 1939), and patents of addition.

[2] German Patent Specification No. 744,871, "Centrifugal Pump" (issued January 27, 1944).

[3] Same author: "Schleuderpumpe mit umlaufendem Gehause" (Centrifugal Pump with a Rotary Casing). Zeitschrift des Vereins Deutscher Ingenieure, Vol. 84, 1940, No. 22, pages 373 to 376.

[4] British Patent Specification No. 664,820, "Improvements in or Relating to Fluid Seals" (issued January 16, 1952).

The Institute of Metals

ANNUAL GENERAL MEETING

No. III—(*Concluded from page 524, April 10th*)

THE discussion on the symposium entitled "The Control of Quality in the Production of Wrought Non Ferrous Metals and Alloys" which formed part of the Institute of Metals annual general meeting was continued on March 25th. Abstracts from the proceedings of the afternoon session are given herewith.

Dr. R. T. Parker (Aluminium Laboratories, Ltd.): I should like to make a comment at this late stage in the meeting on the way in which the quality of cast material has been discussed. The general title of this series of symposia is "The control of quality in the production of wrought non-ferrous metals and alloys," and we are ultimately interested in the wrought material which is going to result from the cast shapes which have been produced. I admit that in the main most of the papers do refer to the ultimate objective which they have in mind for their materials. It is, however, a little obscure in one or two cases. I would hand a bouquet to Roberts and Walters in this respect, because on page 366 they set out extremely clearly what the objectives are in their minds for the quality of their materials. They list them from (*a*) to (*h*), and I would draw attention to the fact that they mention such points as that "the composition must be such that mechanical working can be carried out with maximum efficiency," and that "Since efficient working is generally associated with a high working temperature, the slab must be free from those impurities that cause high-temperature embrittlement," and that the grain size and structure must be correct. I gather from the subsequent discussion that all the people in the different industries are aware of the need to keep such objectives in mind, but nobody has set them out so clearly as the representatives of the zinc industry. I was glad to hear Mr. Staples say that texture does enter into his consideration in the preparation of material. I feel, however, that if all the discussion had been directed a little more specifically towards the properties of the material which is going to be produced from these shapes, we might have profited more from it. In that respect I would say that, contrary to the views of some people, the paper on statistical control did not go far enough. Consideration is given there to the control of the particular processes which we have in mind—control of gas content, for example, and control of temperature—but surely we have to go further than that and control the qualities of the material which are being produced in the remelt by the properties of the material which is being rolled or used by the ultimate user. I think that we are going to get into very deep water with the statistical work if it is to be carried out on the lines described, and this paper is to be the basis for the whole of the symposia on quality control. I think that the same comment, that we must be very well aware of the ultimate use of the material, underlies the plea of Dr. Smithells for really fundamental work to be carried out if we are to make any progress in the control of quality. I think that Dr. Smithells, on the two occasions on which he has spoken, has done very well as shop steward for the research workers' union. I have no doubt that the work which his organisation is doing on gas, where he has given us the benefit of their experience, and the work which is being done in our own organisation and all over the industry on the processes of casting, must form the basis for the better control of quality. I had hoped that some of my colleagues would tell you something about our work on the continuous casting process, which we have used for some time now, but fundamentally there is still a good deal to learn. I think that our control of the casting process should really be exercised by a sort of remote control and not necessarily by an immediate control in the foundry.

Mr. L. C. Batchelor (Imperial Chemical Industries, Ltd., Metals Division): Dr. Singer, in his conclusions, brings out the importance of statistical control. This method, I think, is likely to be developed to a much greater extent in the later papers, dealing with the fabrication and working of the materials. It is very difficult to look at a casting and be able to say that it is a good one. It is often possible to throw the really bad ones out, but there comes a stage where we have to let it go, and quality control there does depend on the result of subsequent treatment. I think that there are two main methods of statistical control which we can probably insert between casting and the final product. One method involves the recording of the results of examination of samples. In this there is a risk that the samples, however they are taken, may not represent the bulk. The second method is to have 100 per cent inspection, to ensure entire freedom from defects. This, in my experience, has never been, and I think that it cannot be, entirely satisfactory, because many of the defects will escape detection. I think, however, that a combination of these two methods on a statistical basis will go a long way towards improving quality and to show a trend on which action can be taken. Dealing with the practical side of the control of quality, I think that in brass and copper alloy production it is very important to have individual operators with the required skill. They should work on medium-size furnaces and they should have the responsibility for their own mould preparation. It is also preferable, in my opinion, for a caster to produce fairly large batches of one particular quality and these can be followed through the later stages of production. Casters should specialise in a particular shape, whether a billet or a slab, and whether it be 60/40, 70/30 or whatever it may be.

Dr. A. R. E. Singer: There has been much talk about primary and secondary variables. There is nothing very fundamental about a primary variable. A primary variable in one process may not be primary in another; it all depends on the process. Taking a particular process, such as the melting operation itself, a primary variable is a quantity which has an immediate and direct effect upon the product, and it is a quantity which we value and use in the final product. In the case of an ingot it is obviously the structure and properties of the ingot which we require, and with a metal bath it is the temperature and composition of the metal. It is important that in metallurgical industry we do not try to justify our prejudices. It is very easy to do that. Each one of us is prone to the same sort of trouble. In many ways we tend to be self-satisfied, to be satisfied with the present position. In some cases primary variables, and some secondary ones, are metered and measured and used for control purposes by the most advanced firms and in particular cases, but most of the material which is processed in metallurgical industry is not subject to control in the case of the primary variables. There is a field of work there to be done, and the quality of the product can be very much enhanced by trying to control those primary variables. I was a little shocked by the remark of Mr. Talbot that the X-ray set is out of place in the factory. We have to be fairly open-minded about this. We know that X-ray sets and other complicated pieces of equipment are likely to be damaged in the factory, and it may be difficult to install and maintain them. Nevertheless, we have to keep an open mind about it and, if the process demands it, we shall have to put it in the foundry or wherever else it is needed, and if we do not our competitors will be quick to do so and catch up with us. We must not close our eyes to the possibilities now before us to obtain closer and better control in the foundry or in any other part of the metallurgical industry. That is the main point which I would emphasise in this paper. There are enormous opportunities before us. They may seem difficult of achievement at the moment but they will be achieved, and if we direct our efforts towards achieving them we shall increase the quality of our product much more rapidly than will otherwise be the case.

The proceedings then terminated.

Technical Reports

Test of a 40-Ton Derrick with Unstayed Mast. (Report No. 81, R.B. 641.) By J. McCallum, B.Sc. The British Shipbuilding Research Association, 5, Chesterfield Gardens, Curzon Street, London, W.1.—Measurement of mast deflections and stresses were made at the works of William Gray and Co., Ltd., West Hartlepool, during a test carried out on a 40-ton derrick with unstayed mast. There are notes upon the arrangement of the mast, the disposition of the strain gauges, the mast deflection and the test procedure. The experimental results are given in detail, together with particulars of the mast and derrick arrangements. A comparison of the results has been made with the predicted values, and quite good agreement obtained for mast stresses, although some discrepancies are apparent in the comparison of mast deflections, where, in one instance, the theoretical value was about six times that recorded in the experiment. The results of the experiment are recorded in tabular statements and diagrams, and in Appendices I and II typical calculations for stresses and deflections in the mast on a theoretical basis are given.

The International Motor Show at Frankfurt

No. I

THE International Motor Show at Frankfurt a/M, which took place from March 19th to 29th, was the second one organised since the war. The organisers, the Verband der Automobil-Industrie, have decided to stage this exhibition at bi-annual intervals only, as automobile engineering seems to have passed the phase of outstanding new developments and has settled down to a stage governed by steady, though less spectacular, detail improvements, hardly justifying the expense of annual exhibitions.

By this decision the Show has actually gained technical interest without losing its attraction to the public, for the number of visitors, more than 650,000, who passed the turnstiles in ten days, proved that a Show—where it is actually possible to place an order and get delivery either at once or in a very short time—is always likely to attract customers.

This year's exhibition was on even grander scale than the 1951 Show, and must be acknowledged as the largest automobile exhibition so far staged. The floor space of the exhibition halls had been further increased, and cover almost 15 acres, and about 8 acres of open air parks were allotted to heavy vehicle demonstrations and to all sorts of equipment in actual operation. The vast space available gave exhibitors the opportunity of presenting their vehicles with an air of uninhibited showmanship. The largest manufacturers like Daimler Benz, Ford, Auto-Union, Volkswagen and Bosch, had their own exhibition halls, which were lavishly, but orginally, decorated.

Tiring though it is to inspect the contents of an exhibition housed in nineteen large halls and pavilions, the German Motor Show well deserves the interest which was clearly demonstrated by the great number of overseas visitors and exhibitors. Apart from sixteen German motor manufacturers, showing some thirty different models, there were sixteen American firms, five French, two Italian and two Czechoslovak exhibitors. The British contingent consisted of fourteen makes, including most cars of the Austin-Nuffield British Motor Corporation, the Rootes Group, and the Ford, Jaguar and Rover companies. An exploded model of the Rover gas turbine in particular was the centre of attraction for thousands of technically minded visitors.

The German Motor Show had special interest for British visitors, for in the last two years German motor manufacturers have proved to be the strongest competitors of the British industry in the battle for the chief Continental markets. Of the 100,000 cars exported last year by German firms, about 80,000—roughly the same number as that exported by British firms to the Continent—were sold to European countries, mainly Belgium, Sweden, Switzerland and Holland, while only 20,000—compared with approximately 200,000 British cars—went overseas, in particular to the Argentine, Brazil, Chile and South Africa. These export figures as a whole do not yet indicate any immediate danger to British exports, but it must not be overlooked that the German export gains were made against a powerful international competition in countries where no restrictions on imports existed and where the choice of the buyer clearly indicates what the world at large considers a success or a failure. The very fact that a great number of cars fitted with air-cooled, two-stroke and diesel engines have been exported, seems to prove that, contrary to the opinion of many cautious sales managers, an unorthodox approach to technical problems pays better dividends than sticking too strictly to existing design principles.

The question, whether or not the German motor industry will continue to intensify its export drive, is difficult to foretell and will depend greatly on the development of the domestic market. The German home market is far from being saturated and, with one motor vehicle per thirty-seven inhabitants (compared to one per fifteen in England), Germany cannot be said to be fully motorised. Though the number of motor vehicles registered in West Germany is greater than that in the whole of Germany before the war, it is claimed that 30 per cent of the 1,500,000 cars registered in West Germany are more than nine years old and due for early replacement. This statement seems strange to the foreign visitor, because the number of pre-war cars seen on German roads is almost negligible compared with that of modern cars among which the Voklswagen plays a predominant part.

On the other hand, it must not be overlooked that high taxation in Germany has made it practically impossible for the average wage earner to operate a car out of income. The vast majority of vehicles are owned by industry, commerce and commercial interest of some kind, and it is estimated that genuine private owners, using cars for their personal requirements, account for only 7 per cent of the vehicles on the road. To ease this situation, the German motor trade and finance organisations have prepared plans to supply reconditioned cars at prices fixed by independent examiners to those who cannot afford new cars. By this means it is hoped to encourage car owners to dispose of their old vehicles at more frequent intervals and to stimulate the sales of new cars.

A certain slackening of the commercial demand, in addition to a temporary shortage of sheet steel, caused a small drop in production during the last months of 1952, with the result that after the spectacular rise in car output in 1950 and 1951 production has slowed down to a more moderate pace (Table I). It seems, however, that this temporary depression has now been overcome for the production figures available for the first three months of 1953 show an increase of about 7 per cent compared with the corresponding figures for 1952. Unless the home market tends to slacken in the current year it can be assumed that the German industry will not increase its export rate of about 30 per cent of its total production to any great extent. A moderate increase, amounting probably to 20,000 units, can be expected mainly in the class of expensive luxury cars and in the class of light family saloons, for which the demand has considerably increased in the last few months.

TABLE I

Type of vehicle	1938	1950	1951	1952	Production, 1952, per cent of		
	Germany	West Germany			1938	1950	1951
Passenger cars	276,800	216,122	267,376	301,139	110	140	113·6
Utility cars	—	3,283	9,246	16,545	—	500	179
Delivery vans up to 1 ton	—	42,923	40,886	41,995	—	98	103
Goods vehicles up to 5 tons	—	35,515	44,219	54,174	—	152	122
Goods vehicles, 5 tons and more	—	6,245	7,619	9,655	—	155	126
Goods vehicles total	80,200	81,683	92,724	105,824	132	130	114
Motorbuses	—	3,812	4,226	4,330	—	112	110
Trolleybuses	—	30	43	367	—		
Road tractors	—	1,131	536	250	—	22	47
Total	357,000	306,061	374,151	428,455	120	140	115

Examining the Frankfurt Show from the view point of an engineer, one is not surprised, in fact one takes it almost for granted, to be faced with a number of constructions which to the average British buyer would appear to be rather unorthodox, but which have become extremely popular on the Continent. It can be said that, with the exception of Ford and Opel, the two firms associated with the American Ford Company and with General Motors, respectively, practically all other cars are characterised by certain design features which, so far, have not been accepted in this country. Two-stroke engines in conjunction with front-wheel drive for all cars below 1 litre capacity, the air-cooled rear engine Volkswagen (which, produced at an annual rate of 135,000, account for one-third of the

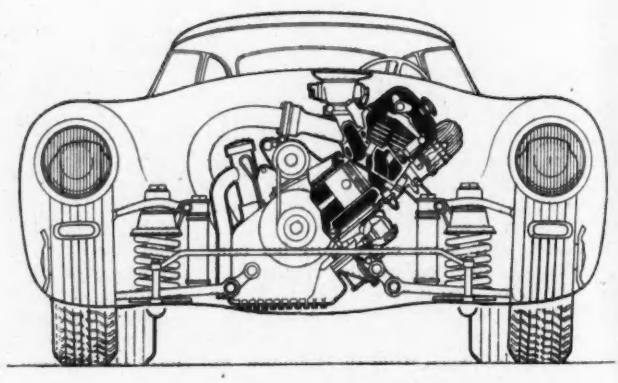


Fig. 1—Phantom View of Mercedes Sports Car

total German production), diesel engine cars, independent all-wheel suspensions, &c., are not exceptions but form the established standards of German construction. As these designs are now sufficiently well known and no longer regarded as revolutionary, any progress shown at the Frankfurt Motor Show reflects more or less an evolutionary development within the limits of the general conception as indicated above.

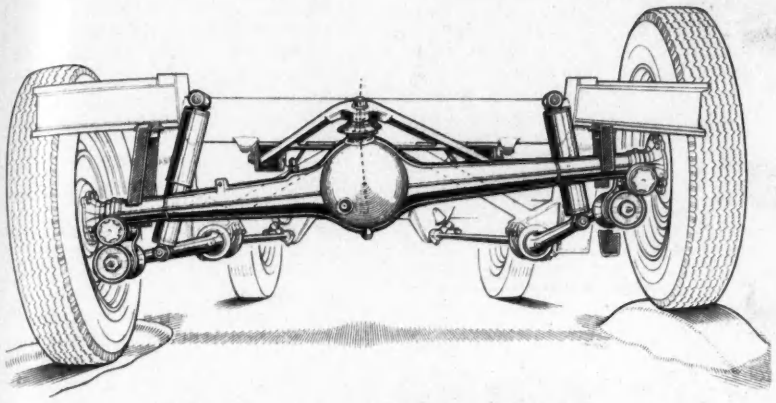


Fig. 2—Rear Axle and Suspension of B.M.W. Car

Seen from this point of view, the stand of Daimler-Benz A.G. did not show anything novel. The 2 and 3 litre Mercédès "220" and Mercédès "300," characterised by their sturdy tubular "X"-frames with rear swing axles and high performance engines, which were first marketed in 1951, have proved very successful in domestic as well as in export markets. With the appearance of these models, the sales of the previous types "V170" and "S170"—fitted with 1·7 litre side-valve engines—have naturally dropped, whereas the demand for the 1·7 litre diesel car has remained steady. About 10,000 of these vehicles are produced annually and they enjoy great popularity because of their general road performance and their unsurpassed fuel economy. Since we last had the opportunity of testing one of these cars the engine has been further improved and now very closely approaches the smoothness and flexibility of a petrol engine.

The centre of interest at the Daimler-Benz stand was the sports car, type SL300, which won last year's French Le Mans race, the German Grand Prix and the recent 2300-mile Mexican Pan-American road race. Fig. 1 is a cross section of this car, showing the front suspension, the inclined position of the engine with its interesting valve operating gear and the air intake through a scoop at the top of the bonnet.

An interesting exhibit at the stand of Carl F. W. Borgward A.G., was the "Hansa 2400" four-door saloon of integral construction with independent four-wheel suspension, powered by a six-cylinder, 2·4 litre engine which develops 82 b.h.p. at 4200 r.p.m. The car is normally fitted with a four-speed, synchro-mesh gearbox but a full-automatic hydraulic transmission of the firm's own make which will be described later, can be fitted. Borgward also showed a four-cylinder diesel engine of 1·76 litre capacity having an output of 40 b.h.p., which can be fitted into the "Hansa 1800" car.

Bayerische Motorenwerke A.G., a firm well known as manufacturers of motorcycles, and in pre-war days also of fast sports cars, presented, for the first time since the war, a newly designed car, the B.M.W. "50," a spacious six-seater saloon of pleasing appearance, propelled by an o.h.v. push-rod operated 2 litre engine of 66mm bore and 96mm stroke, developing 65 b.h.p. at 4400 r.p.m. The car is unusual among German cars in as far as the whole conception is based on orthodox, i.e. pre-war principles, but each individual component has been newly designed in the light of the latest experience. The engine, for instance, still retains the nowadays unusual stroke-to-bore ratio of 1·43 : 1. It has an oil cooler which, similar to that of the latest Mercédès engines, is placed inside the water jacket, and the carburettor with its thermostatically controlled exhaust heating device is completely enclosed in a quick-opening air cleaner and silencer box. Also unusual is the mounting of the gearbox separate from the engine below the front seats, providing a flat, unobstructed floor for the passengers in front.

The front suspension employs wishbones of practically equal length in conjunction with longitudinally mounted torsion bars, and the steering-box is of the bevel gear form, the vertical shaft carrying the steering-arm being positioned parallel to the king-pins. Another item of interest is the layout of the rear suspension, which comprises a live rear axle suspended by transverse radius arms and torsion bars (Fig. 2). The drag and the torque reaction is taken by a triangular construction of steel tubes which form a link between the top of the rear axle housing and a rubber mounting on the rearmost cross member. Though expensive, this layout is claimed to be very effective in as far as by a suitable selection of the position and length of the spring shackles the natural frequency of the spring system can be maintained at the rate of about 85 cycles per minute, irrespective of the load. Another detail worth mentioning is the very stiff frame formed of amply dimensioned box-section longitudinal members and tubular cross members.

The "V.W." car of the Volkswagen-Werk has been altered in minor details only, as far as its general appearance is concerned. Great care, however, has been taken to improve its riding comfort by fitting it with torsion bars of softer spring characteristic and longer telescopic dampers for the purpose of reducing the natural frequency of the fully loaded car to the physiological optimum. The cooling of the engine, particularly of the valve seats, has been improved by a clever arrangement of baffle plates inside the cowling and the engine noise has been damped by softer mounting and by better sound insulation. Most important, however, is the replacement of the old four-speed crash gearbox by a constant-mesh gear with all but the bottom gear synchronised. The design of the new synchromesh gearbox would hardly be worth mentioning if it were not for the fact that, in accordance with the general tendency of the firm to make all components interchangeable, the designers have succeeded in keeping the overall dimensions of the new gearbox strictly within the limits of the old one.

As shown in Fig. 3, all the four speeds of the gearbox are indirect, the second, third and the fourth (overdrive) gear being synchronised. The dogsleeve of the second speed is externally geared and can be alternatively put into engagement with the first and with the reverse gear. With the above-mentioned and several other minor detail improvements, the "V.W." has considerably gained in its general functional value.

One cannot describe the "V.W." without mentioning the sports version, the Porsche 356, a car capable of doing about 110 m.p.h. The Porsche car, which was shown at Earls Court in 1951 and described in THE ENGINEER of November 2, 1951, is being built by the Dr. F. Porsche K.G., a development centre founded by Dr. Porsche, the designer of the Auto-Union

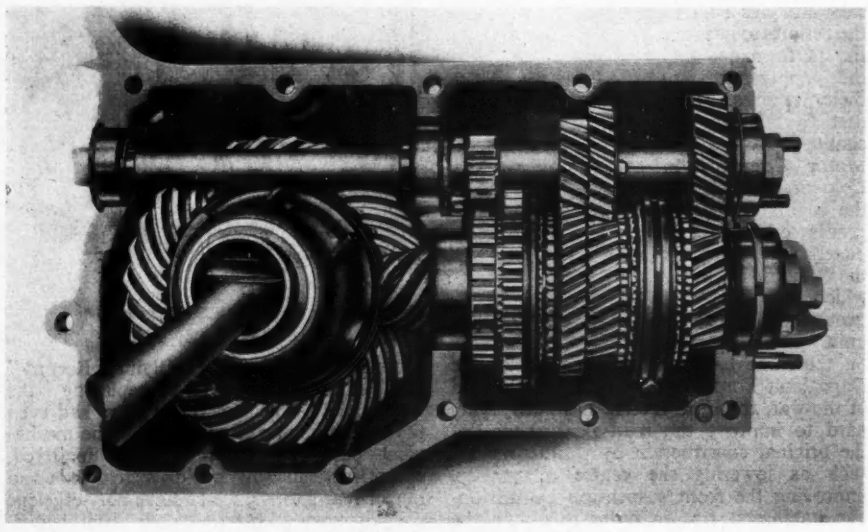


Fig. 3—Four-Speed Synchromesh Gearbox of the Volkswagen

Fig. 4—Ford "Taunus M 12" Car

racing cars and of the Volkswagen. Its design is to a large extent based on that of the Volkswagen, essential components of which are being incorporated in its construction. The latest version of the Porsche range is fitted with a 1·5 litre, four-cylinder, air-cooled engine of 80mm bore and 75mm stroke, developing 70 b.h.p. at 5000 r.p.m. The specific output of 46 b.h.p. per litre is more than double that of the "V.W." engine: it has been achieved by a compression ratio of 8·2 : 1, an ingenious valve arrangement, chromium-plated aluminium cylinders and a built-up crankshaft with roller bearings in the big ends. A further outstanding feature of the Porsche car, a new synchromesh gearbox, is to be described later on.

The strong competition of the Volkswagen has naturally caused concern among the other makers of medium-sized family cars and has spurred their efforts to improve the performance and the appearance of their vehicles. The first to take up the challenge was the Ford Motor Company in Cologne, which at the beginning of last year introduced a completely new model of the "Taunus," a car which for the last twenty years had been built more or less on the same basic design principles as the Dagenham Ford "Prefect." Since the end of the war, the Ford factory has been trying hard to improve the road performance of the original construction by various means, such as lowering the centre of gravity, improving the front suspension by torsion-bar stabilisers, &c., in order to obtain the springing and road-holding properties nowadays expected from every Continental car, irrespective of its size. The new "Taunus M12" is a complete departure from the previous design. The car (Fig. 4), which in its appearance somewhat resembles the Dagenham built "Consul," has a standard wishbone-cum-coilspring front suspension, a live rear axle with semi-elliptic leaf springs, telescopic front and rear dampers, a three-speed gearbox with steering column control and a two-door integral body having attractive lines. The 1·2 litre s.v. engine is basically the same as used previously but it has been greatly improved by redesigning the inlet ports, strengthening the crankshaft and the fitting of adjustable tappets and thermostatic control. By these means the output has been increased to 38 b.h.p. at 4250 r.p.m. With the now sufficiently powerful engine, a considerably wider track and the improved suspension, the new "Taunus M12," the weight of which, in spite of all improvements, has only gone up to 17 cwt, has now a general performance equal to the best cars of its class.

Another new car, first shown at this exhibition, is the 1·5 litre "Olympia Record" of Adam Opel A.G., replacing the "Olympia," which for many years had been the most popular German car. The mechanical part remains practically unaltered, except for a new hypoid drive rear axle and longer rear springs, which have poly-ethelene pads interposed between their three leaves. The integral body has been lengthened by 4½in to give "inter-axle" accommodation for all passengers and has been completely restyled. The centre of gravity has been lowered by fitting the car with tyres of the new popular size, 5·60–13, and the new model has in every respect, apart from its size, the appearance of a well-styled American car.

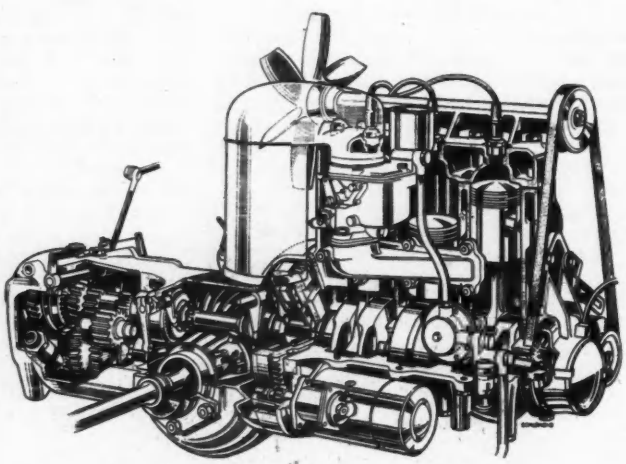


Fig. 5—Three-Cylinder, Two-Stroke D.K.W. Engine

Among the numerous German two-stroke cars the new front-wheel drive D.K.W. "Sonderklasse" of Auto-Union A.G., has the same chassis and body as the "Meisterklasse," which, built at the rate of about 25,000 units per year, is by far the most popular car of this class. The new model, however, has a three-cylinder, 896 cubic centimetres engine of 71mm bore and 76mm stroke, and develops 34 b.h.p. at 4200 r.p.m. The engine, though originally developed as early as 1939, has not been previously made in West Germany, but some similar engines were exhibited two years ago at the Leipzig Fair by the I.F.A., the nationalised heirs to the Auto-Union assets in the Soviet Zone. Contrary to the 684 cubic centimetre, two-cylinder engine of the "Meisterklasse," which was built for more than twenty years without any major alterations, retaining the essential features of the water-cooled motor-cycle engine from which it was originally developed, the new three-cylinder shows a close approach to modern automobile practice (Fig. 5). It is longitudinally mounted in the chassis ahead of the front axle and radiator, and the torque is transmitted to the three-speed synchro-mesh F.Z. gearbox through a freewheel unit, interposed between the single-disc clutch and the gearbox, and returned from there to the spiral-bevel, front-axle drive. It is claimed that the "Sonderklasse" has a maximum speed in excess of 70 m.p.h.

Turning now to a survey of major components, one is inclined to think that, apart from a seemingly more advanced approach in respect to the general conception of car design, the detail construction varies but little from the international standard.

Progress has been made in the design of gearboxes, and the crash gearbox, which two years ago was the rule not only in the Volkswagen, but also in practically all two-stroke engine cars, has, with one exception, disappeared. The adoption of the synchromesh gear change had to be made in the majority of cases without increasing the distance between the bearings and the overall dimensions of the housing, and much thought was given to the design of short synchronisers. The constant-load synchroniser still used in a number of British cars was never popular in Germany, most cars, such as the Mercédès, Borgward, Ford, Opel and, nowadays, Volkswagen, employing the Borg-Warner baulk synchroniser. A new synchromesh gear, developed by the Zahnrad-Fabrik Friedrichshafen A.G., has been adopted by Bayerische Motorenwerke, Auto-Union, Goliath, and others; it is marketed under the name of "Sperrsynchronisierung" (Lock-Synchronisation), and provides a positive lock of the gear shift lever during the synchronisation period. As shown in Fig. 6, the internally splined dog sleeve 1 rests on the externally splined carrier 2, which is keyed to the driving shaft. The internal cone clutches 3 are fitted with slotted extensions in which the locking pieces 4 (two for each friction clutch) can slide radially. The initial axial shifting of the dog sleeve causes engagement of the friction surfaces 5 and produces an angular displace-

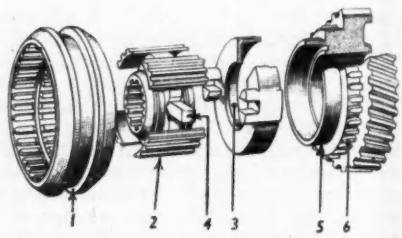


Fig. 6—Positive Lock Synchronisation Detail

ment of the clutch relative to the sleeve, causing the radial locking pieces to ride up cam profiles machined in the hub of the sleeve carrier, and spread towards the inner surface of the sleeve. The strong pressure of the locking pieces prevents any further shifting of the sleeve until the speed of the sleeve carrier and the friction clutch rotate at the same speed. The differential torque

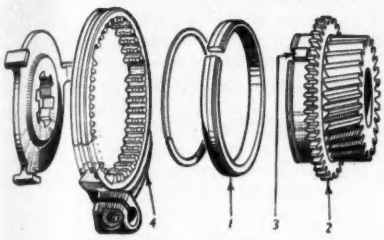


Fig. 7—Ring Synchronisation Gear

between the rotary parts having ceased, the locking pieces retract radially, and permit the dog sleeve to be shifted into engagement with the external dogs of the roller-mounted gear wheel 6. The new Z.F. gear is effective, easy to operate, and makes "cheating" of the synchronising mechanism practically impossible.

Another interesting four-speed gearbox, synchronised in all gears, is that of Dr. F. Porsche K.G., developed for use in its sports cars (Fig. 7). Instead of the orthodox cone clutch, a split friction sleeve 1, 8mm wide, of hardened chromium-molybdenum steel and similar in appearance to a piston ring, rests on the cylindrical extension of the gear wheel 2. It is axially located by a spring washer and caused to rotate with the gear wheel by a tongue 3 which protrudes into the ring gap. The axial shifting of the internally splined dog sleeve 4 forces the dogs over the chamfered part of the friction ring, thereby compressing it and initiating the synchronising process. The differential torque between the gear wheel and dog sleeve causes the trailing end of the ring to bear upon the key which now acts as a fulcrum and produces in the ring an internal tension (additional to its initial static tension), which is opposed to the direction of rotation. This effect, which can be compared to the self-energising action of a leading-shoe brake, is very powerful and, as the braking effort is proportional to the differential speed, synchronisation can be effected in a very short time. The axial movement of the dog sleeve during the synchronisation period is, though not positively locked, greatly restricted by the friction between ring and dog sleeve. The self-energising effect of the friction ring ceases when the driving and the driven part are running at the same speed, and the dog sleeve can then be slid into engagement. The Porsche synchroniser is simple and, because of its powerful braking effort, shortens the synchronising period to such an extent that gear changes at high speed can be effected without any noticeable interval.

It goes without saying that German manufacturers are just as much alive as those in other countries to the need for providing an automatic gear, cheaper and simpler than that of American cars and more suitable for Continental engines of small capacity. At the 1951 Frankfurt Show, Borgward first showed a single-stage hydraulic torque converter which was then received with some criticism, as it seemed unlikely to obtain reasonable efficiency at the planned conversion ratio of 5 : 1.

The converter was not, as prognosticated, a success, and the newly developed automatic transmission (Fig. 8), laid out for the "Hansa 2400" car, has eliminated the basic disadvantage of the original design by employing a mechanical reduction gear, consisting of a train of helical gears with a reduction ratio of 1·5 : 1 behind the single-stage hydraulic unit. The latter consists of impeller, turbine, and of the converter casing which carries the guide vanes.

In the "low" position the converter casing is connected to the bell housing by an oil-operated cone clutch and the hydraulic unit runs as torque converter with a maximum conversion ratio at stalling of about 3·6 : 1. The mechanical reduction gear is in operation increasing the maximum torque ratio to 5·5 : 1. In the "medium" position, the connection between converter casing and bell housing is broken and the impeller and turbine are coupled by an oil-operated cone clutch. The whole hydraulic part rotates as an integral unit, and the torque—as in the "low" position—is transmitted through the reduction gear. In the "high" position the layshaft is separated from the output shaft by a dog clutch and the latter connected by a multi-disc clutch with the main shaft; crankshaft and output shaft are then rigidly coupled.

The dog clutch and the multi-disc clutch are also operated by oil pressure, generated by a small oil pump in the gearbox. The change-over from the "low" through the "medium" to the "high" position is effected automatically in the usual way under the influence of road speed and engine load. A centrifugal governor at the output shaft and a rotary valve connected with the gas pedal control the flow of oil to the cylinders, which operate the various clutches.

The design of the Borgward hydraulic transmission appears to be comparatively simple and inexpensive. Its efficiency will greatly depend on the power-weight ratio of the car and on conditions of road and traffic. As a novel approach to the problem of automatic gears for European cars, its behaviour in service operation will be watched with interest.

(To be continued)

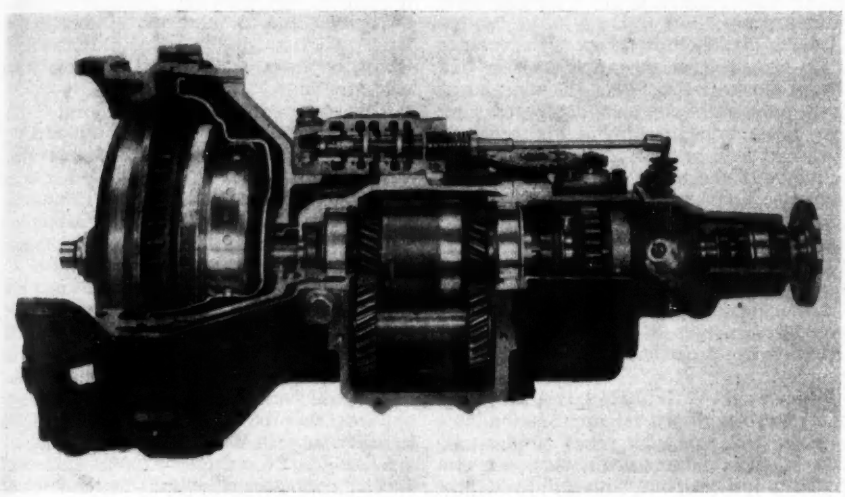
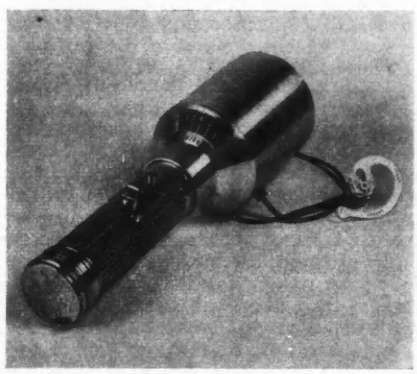


Fig. 8—The "Hansa 2400" Hydraulic Transmission Unit

A Simple Radio-Activity Survey Instrument

A SIMPLE and rugged portable gamma-radiation survey instrument, which is shown in the accompanying illustration, was recently developed for the U.S. Navy Bureau of Ships by the electronic instrumentation laboratory of the National Bureau of Standards, Washington, D.C. The instrument requires no microammeter and facilitates radiation levels to be read directly from a potentiometer dial. To read an unknown value of radiation, the operator turns the dial to the point at which an audio-oscillation just begins. This point is determined aurally with a small earphone. The aural indication is particularly convenient for plotting contours of equal radio-activity; with the dial set for a particular radiation level, it is an easy matter for the operator to walk along and locate aurally a series of equally radio-active points. Like many other gamma-radiation survey instruments, the device uses a halogen-filled Geiger-Muller detector tube, together with a vibrator high-voltage power supply operating from torch batteries. The output current of the detector is proportional to the incident radiation. The heart of the aural indication method is a thyratron relaxation oscillator circuit. If the potential difference between the grid and cathode of the thyratron valve exceeds the firing potential, the circuit will oscillate. The unknown voltage derived from the detector tube current is applied to the outer terminals of the potentiometer, while the thyratron grid is connected to the moving contact. The potentiometer setting at the threshold of oscillation thus depends on the radiation level and the potentiometer dial can be calibrated directly in radiation units.



Gamma Radiation Survey Instrument

ALUMINIUM SHEET PRODUCTS.—The Northern Aluminium Company, Ltd., has recently published a brochure, "Noral Sheet Products," Part 1, which gives the standard sizes, limits and tolerances for flat sheet, coiled sheet and plate. Sheet and plate specifications appear in the general notes and then three sections deal with flat sheet, coiled sheet and plate. Each section contains information such as standard sizes, manufacturing limits and tolerances on length, width and thickness.

The Institution of Naval Architects

ANNUAL SPRING MEETING

No. III—(*Continued from page 537, April 10th*)

ON Thursday afternoon, March 26th, the meeting continued with the reading of the paper :

THE EFFECT OF RADIAL PITCH VARIATION ON THE PERFORMANCE OF A MARINE PROPELLER

By Professor L. C. BURRILL, M.Sc., Ph.D., and C. S. YANG, M.Sc.

SUMMARY

This paper is a description of the results of an investigation, by means of strip theory calculations, of the comparative effects of various forms of radial pitch variation on the efficiency and performance characteristics of a marine propeller working in a uniform stream, and also in various non-uniform wake streams representative of twin-screw and single-screw wake patterns. The details of the basic propeller are given, together with a note of the pitch variations examined. A table gives the calculated results for the basic propeller in several variable wake streams and a graph shows the K_T and efficiency curves. The results of the examination of the effect on performance of the effect of radial pitch variation are set out in a tabular statement and another table gives efficiencies and other values for propellers designed for various minimum energy loss conditions. From the calculations it is noted, among the conclusions, that for overall efficiency the adoption of radial variation of pitch appears to give no material advantage, and this applies also to the alternative methods of design, based on the principle of minimum energy loss, which have been examined.

DISCUSSION

Mr. R. W. L. Gawn : This paper concentrates very ably and thoroughly on one important aspect of propeller design. The conclusion that there is no material advantage to be gained from the adoption of a radial variation of pitch is very important, because you can use any variation for design with no cavitating and other conditions. As I follow the paper, this applies to the particular form of propeller investigated, of about 1·21 pitch ratio and 0·514 blade area ratio; perhaps the authors will state whether their work would justify a broader application.

Years ago it was established from model tests that a small improvement of propulsive efficiency of the order of about 2 per cent could be obtained by reducing the pitch of the propeller near the boss by as much as 20 per cent. Published results indicated that this was true for some, but not for all types of single-screw merchant ships included in the investigation. This feature has also been tested for the centre screw of a model of a triple-screw warship, but the propulsive efficiency was reduced by fully 2 per cent as compared with a constant pitch propeller.

According to the paper, the propeller with pitch grading No. 2, namely, with increasing pitch from tip to root, has a lower efficiency than others in a wake of 0·3, namely, 0·68 as compared, for example, with 0·71 for pitch grading No. 5. This difference is equivalent to 4 per cent of machinery horsepower, and prompts the question whether the authors have arranged for any experiments to confirm the results.

Section 6 of the paper covers a variety of methods of assessing the minimum energy loss, and I ask if the authors have any impression from their work or their experience as to which is the best method to follow. It would appear that the Lerbs condition yields a lower efficiency at high wakes than the others that are considered.

Professor Dr. W. P. A. van Lammeren : The results of Professor Burrill's analysis of a number of propeller calculations are generally in agreement with my own experience. The widely different pitch variations examined give small differences in overall efficiency, both in a uniform and a variable velocity field, if we neglect the effect of the rudder. It has been proved by theory and experiment that an advantage can be gained from an extra increase of pitch towards the propeller boss if there is a rudder behind the propeller.

The calculations for the original propeller working in different variable wake streams show that the splitting up of the overall efficiency into its components is only of academic interest so long as the determination of the mean speed of advance depends on an arbitrary definition. Actually the calculation of the propulsion components becomes still more complicated if the effect of rudder, inhomogeneity of flow in the circumferential direction and consequently unequal distribution of thrust deduction over the screw disc are taken into account. If we deduce the components in the usual way from model test results, the latter effects are automatically included. They can be analysed separately if we replace the usual open water test by a propeller test in a velocity field equal to that behind the model or ship in question. This could be done in a cavitation tunnel provided with means for reproducing arbitrarily given velocity fields. Such means are under construction for the cavitation tunnel of the Wageningen Ship Model Basin, and I hope to give particulars of this construction in a future paper.

I agree that there is no special advantage to be gained from the application of the various alternative methods of design based on the principle of minimum energy loss if we apply the sections given in Fig. 1 in the paper. If we use these methods, however, applying sections with shock-free entrance (Karmann-Trefftz sections), the blade area ratio in general may be decreased compared with that necessary for propellers having sections of orthodox shape. This will lead to an improvement in efficiency of 2 or 3 per cent. The main advantage of the adoption of these procedures is that it allows us to design cavitation-free propellers with a fair degree of accuracy.

Professor E. V. Telfer : I think it is not quite capable of general appreciation how restricted this particular series of investigations is. The authors are not dealing with model propellers, but with full-scale propellers, and that has a lot of repercussions, because it eliminates very controversial intervention. I think that if a similar investigation were made on the model scale the results would be different, for we cannot throw away the influence of blade resistance.

There is still an inter-relation between blade resistance and pitch and it is difficult to divorce the two particular problems. One thing which arises from this confronting of the authors' method with actual experiment is the fact that it may not be sufficiently penetrating to test these particular issues. I fully endorse Mr. Gawn's point that it would be interesting to see these calculations checked by model experiments.

The " thrust-identity efficiency " is not an efficiency ; it is useful to call it so, but it is not efficiency in the real sense of the word. You can call it a pseudo efficiency, but it has not the right to be called an efficiency at all.

I would like Professor Burrill to explain his point of view at greater length. The authors are thinking that by getting higher and higher nominal efficiency they are getting higher results, whereas they are getting the very opposite, for if they endeavour to improve the nominal efficiency they are making the real efficiency worse. To get an idea of wake scale effect you must have a clear idea of the behind efficiency of the propeller if you use the nominal efficiency.

Mr. A. Silverleaf : On the method of analysis and comparison, the paper advocates a most admirable and desirable use of propeller theory for accuracy in comparative calculations. The discussion in the paper of the alternative methods of assessing propeller efficiency in variable wakes, based on the different mean advance speeds, helps to clarify the problem considerably.

At the N.P.L. about a year ago we began experiments that Dr. van Lammeren has indicated, and quickly came against the problem of how to assess the mean speed of advance and arrived at the various methods which Professor Burrill and Mr. Yang have summarised—the integrated mean velocity or volumetric mean—but the virtual efficiency, the true mean efficiency, cannot be measured in that way.

The analysis in the paper helps us to understand the physical meaning of the term relative-rotative-efficiency. I have always considered this to be a measure of the change between the torque coefficient in the behind and open conditions with the thrust-identity method and the torque-identity method. Now it is clear that we should consider relative-rotative-efficiency as a ratio in going from uniform speed to a flow in variable conditions. If that is so, it seems a good time to dispose of the term " relative-rotative-efficiency " and to substitute a more useful term, and it might be called variable flow factor or ratio or even the variable flow efficiency factor.

The statement that no significant gains or losses in efficiency occurred by making reasonable pitch variations accords well with modern design experience. What does matter is effective pitch to give favourable leading edge shock-free conditions.

Dr. J. F. Leathard : It should be made clear that the Betz condition applies to hydrodynamic efficiency, and no account has been taken of the blade efficiency for these particular sections. Thus, the Betz condition implies that the hydrodynamic pitch angle is inversely proportional to the radius, which means that it gradually increases towards the root of the propeller. This actually suggests that the root sections are operating at very unfavourable angles of incidence and giving rise to bad blade efficiency, so that a propeller having good hydrodynamic efficiency automatically implies that the blade efficiency is worse than it was in the previous condition.

Further, the thrust coefficient obtained with any particular blade section is dependent on circulation at that section, which is dependent in turn on the hydrodynamic pitch angle. The thrust coefficient and consequently the lift coefficient is directly related to the circulation of that section. Therefore a certain hydrodynamic pitch angle is automatically linked with a certain thrust coefficient and lift coefficient in that section.

On those lines, we find in Figs. 3 and 5 of the paper that, for the different pitch variations which ensue, all the thrust coefficient curves cross at round about $x=0·65$ to $0·7$. I confirm that if you design a propeller on the basis of the optimum Betz condition you will always find that the circulating inflow factor coincides with the basic propeller,

but it will vary as you move away from that particular section of 0·65 to 0·7.

I have tried to modify the Betz condition to take account of the blade friction of each particular section, and it is possible to show that there is some modification to the inflow angle which is dependent upon the ratio of lift to drag coefficient. I got a certain relation and I tried out one or two pitch variations on that basis, but it did not make a great deal of difference to the overall effect.

The second paper presented on Thursday afternoon, March 26th, was entitled :—

FATIGUE IN SHIP STRUCTURES

By R. Weck, Ph.D.

Summary

The paper mentions the characteristics of the failure resulting from a large number of load applications and discusses the possibilities of fatigue failures in ship structures. Failure in redundant and non-redundant structures is considered, together with its prevention as related to the possible consequences, and it is noted that although in ship structures a fatigue failure generally propagates slowly a sharp fatigue could propagate quickly under certain circumstances. It is conceded that welded ships are more likely to develop fatigue cracks than riveted ships and the behaviour of each method of joining is reviewed. The objectives of the full-scale fatigue tests are given and the test pieces described, together with the chemical and physical properties of the material used. There is an account of the testing procedure and cross sections of a test specimen show the distribution of longitudinal and transverse stress. The specimens are described and a series of tables detail the results of the tests, which are summarised in a final table.

Discussion

Mr. James Turnbull : There is a great deal of confusion because people talk broadly about fatigue in ships and do not mention whether they are speaking of fatigue in panels of shell plating, in a stiffener or in the whole hull structure. Fatigue in panels of plating in the panting area of ships' structures was undoubtedly experienced quite often some years ago, but largely as the result of alterations in the design of the structure in this vicinity, this trouble is now rare and we do not experience trouble due to fatigue in a frame to any serious extent.

The main item of fatigue is in the bending forces to which a ship is subjected and in that connection I am not quite certain whether or not fatigue is important. A welded ship is not made like a precision instrument ; she is fairly rough by those standards. When a ship goes to sea and for the first time experiences fairly severe forces, at the hatch corners and similar discontinuities, the material flows plastically and there is a certain readjustment of the structure and subsequent applications of reversals of load may cause fatigue failure. I believe that research into fatigue has not been carried out on the material in this strained condition, and research on that matter would help us to gain better knowledge as to whether or not fatigue is important in a ship structure.

Dr. Weck states that " If one set out, for instance, to modify the design of the hull in such a way for the probability of fatigue failure to be very small, the cost to the industry would undoubtedly be a multiple of the cost of repair of such failures." I think that a shipowner is entitled to expect a ship that will not fracture in service. However, it is not only the cost of the repair that we have to consider, but the loss of earning power. I submit that ships can be designed so that they will not fracture in service without resorting to special measures, but merely by taking normal care in the detail design of the structure.

In the paper it is stated that " The classification societies might be expected to have data on the incidence of fatigue failure in ship structures, but in actual fact, I believe, they have not." The author goes on to say that maybe fatigue failures are not recognised as such. The staff of Lloyd's Register is fully aware of the difference between fatigue and brittle fractures and while an attempt is made to ascertain the nature of fractures experienced it is seldom possible.

Mr. D. E. J. Offord : I am in full agreement with the two main conclusions, viz. that continuous fillet welds are undoubtedly to be preferred to intermittent welds and that the low hydrogen electrodes give much superior results to those obtained with the normal rutile covered pattern. These are very important findings and I commend them to all who are dealing with the design of highly stressed welded structures.

I cannot entirely agree with the discussion of the incidence and importance of fatigue failure in ships' structures and no doubt there will be comment upon the statement that after a few years a builder's interest in his product becomes somewhat platonic. This statement is not true so far as warships are concerned, *vis-à-vis*, for the Naval Construction Department takes an active interest in its ships up to the day they are scrapped. So far as the main strength structure is concerned, I have never come across a failure which could be attributed to fatigue caused by fluctuations in main longitudinal stress. If, therefore, the author means main strength structure, I cannot agree with his statement that " the stress variations sustained by the different parts of a ship's structure during its useful life are certainly of a sufficiently high magnitude and occur frequently enough for fatigue failure to become possible." Recent measurements with statistical strain gauges do not, in fact, support his contention. We may get fatigue failures in other parts of the structures such as in badly designed structural supports to imperfectly balanced high-speed machinery, and in panels of bottom plating near the fore end of long ships, due to the variation of stress caused by pitching motion. These are probably corrosion-fatigue failures and I think the corrosion is the more important of the two elements.

The great majority of the serious brittle failures which have taken place in ships have occurred early in their life, long before fatigue cracks could have started in an otherwise satisfactorily designed structure. I therefore cannot agree with the suggestion that fatigue may be a significant factor in brittle failures in ships.

The usefulness of the paper lies in the fact that it gives a technique by which to test pieces of structure under various conditions of loading, to discover points of weakness and positions of stress concentration. The fatigue cracks are, in fact, serving the functions of strain gauges.

I was a little disappointed to find in Figs. 4 and 5 of the paper that the stress pattern in these tests represents a state of affairs rarely met in main strength structures of ships. I wonder if Dr. Weck has thought out a practical scheme of resonant or cyclic loading which would in fact be more representative of the stress distribution in, say, the strength deck of a ship.

Mr. G. M. Boyd : There is little information to establish what proportion of ship fractures are due to fatigue, since most cracks have to be repaired without delay and cannot be opened up for examination. Moreover, the surfaces of the fractures are generally so rusted that the characteristic texture cannot be distinguished. Again, owing to the working of the ship, cracks tend to open and close and the original texture is liable to be damaged or obliterated, a result which may be responsible for the characteristically smooth appearance of true fatigue fractures.

There can be little doubt that many of the small cracks which occur at stress concentrations are in fact due to fatigue, and an example is the fracture which used to occur at the caulking edges of riveted overlap butts. These were no doubt due to the high local bending stresses at these points, combined with surface damage due to caulking and corrosion. An examination of the reports on this class of fracture in an old ship, built in 1907 and still afloat in 1946, indicated a tendency for such fractures to recur at intervals varying from seven to fifteen years.

Information is scanty on the number of extensive brittle fractures which have originated from fatigue cracks, but the proportion does not seem to be great. While some of the origins of such fractures have been found at pre-existing short cracks, the majority have been found at easily recognisable notch effects resulting from defects in design or workmanship.

The topical value of the paper lies in its relevance to the problem of brittle fracture, particularly in welded ships. The role played by fatigue in this problem is by no means clear, but it is relevant, particularly in view of the author's observation that fatigue cracks are more liable to occur in welded than in riveted structures. A fatigue crack is probably the most severe " notch effect " conceivable and such a crack would be a menace if the material in which it occurred were in a notch brittle condition. Evidently it is desirable to devote particular attention to the detail design at critical positions to minimise the possibility of fatigue cracks. Such attention also reduces the liability to the initiation of brittle fractures, even in the absence of fatigue.

Mr. L. G. Stevens : I do not think we need worry very much over the problem of fatigue in relation to brittle fracture for the reasons Mr. Offord has given ; but if there is any danger of fatigue cracks initiating brittle fracture no amount of effort to effect its prevention should be overlooked.

In certain instances the cost of repair may be a great deal more than the cost of prevention. If these experiments can show that provided we have good design and technique the chances of fatigue are not very great, they are very valuable indeed.

Mr. B. N. Baxter : The stress range chosen is too high and bears little relation to the actual stress range met with by the main hull girder of a ship at sea and tables of stress readings on vessels at sea indicate that even during very bad weather the stress range is much smaller than the ± 8 tons per square inch used in the experiments.

The resonance vibration method used caused the specimens to vibrate with a frequency of 4300 cycles per minute and with this high rate it would appear practical to use a smaller stress range, since even if 100,000,000 cycles were needed for fracture, this would take only about sixteen days. 100,000,000 cycles may well be the total number of cycles experienced by a vessel in thirty to forty years' service.

Although considered statistically, the main hull girder of a vessel is in no danger from failure by fatigue, full-scale strength experiments have shown that the local stress concentrations give much higher stresses than those in the main hull girder. At these points of stress concentration, therefore, any local failures should be investigated, the possibility of fatigue failures being kept well to the fore.

Professor E. V. Telfer : From time to time I have been asked what fatigue is

vis-à-vis heavy weather damage. That is one of the most difficult things to decide when we examine what has happened in the structural breakdown of ships which conceivably has been caused by heavy weather. We never quite know how far that heavy weather damage extends, and when we see cracks which were not seen before in heavy weather we are inclined to attribute them to heavy weather damage. On the other hand, an underwriter's surveyor will say that they are probably due to fatigue which has been going on for a long time. On behalf of the owners I have tried to say that you cannot divorce heavy weather damage from the incidence of fatigue, and when you see damage at a particular stage in a vessel's life the chances are that the fatigue was first made possible by the incidence of heavy weather damage, which was unnoticed at the time. We should be very pleased to have an independent view of that from Dr. Weck, for it is one of the most important matters from the standpoint of owners and underwriters.

Dr. H. G. Taylor : The work dealt with in the paper has extended over a fairly long time. It may not be very pertinent to your problems now, but one day you may discover that fatigue is more serious than you have thought it to be. It seems to me that the conclusions reached are that continuous fillets are better than the intermittent ; that staggered fillets are better than chain fillets ; that scallops reduce fatigue strength ; that butt straps do not increase endurance, and that good results are obtained with low-hydrogen electrodes. One is very often told, after a research, that the results are such as should have been decided beforehand. I am sure you could not have come to all these conclusions before you started, and I think these results will stand for a very long time.

(*To be continued*)

Large Capacity Hydraulic Dynamometer

Part of the equipment of the Admiralty Test House for Gas Turbines is a large capacity hydraulic dynamometer of special form and capable of meeting the onerous duties connected with the testing of gas turbines. The specification calls for the dynamometer to absorb 10,000 *s.h.p. over a wide range of speeds, to be directly reversible within a limited period of time and to function when tilted to a specified rake of shaft angle.*

THE Admiralty building at the National Gas Turbine Establishment at Pyestock, which has as its main purpose the testing of marine gas turbines, was opened by Admiral Sir Michael Denny last year, and a description of the test house appeared in THE ENGINEER of March 27, 1953. An important piece of equipment mounted in the test house is a hydraulic dynamometer of special form, which has been built by Heenan and Froude, Ltd., at Worcester. This unit, the " R.F.A. 990 " dynamometer, which can be seen in our photograph, has a total weight of 19 tons and is fitted with a lifting frame, while, to ensure maximum capacity and length of life the main power absorbing parts have been constructed in bronze.

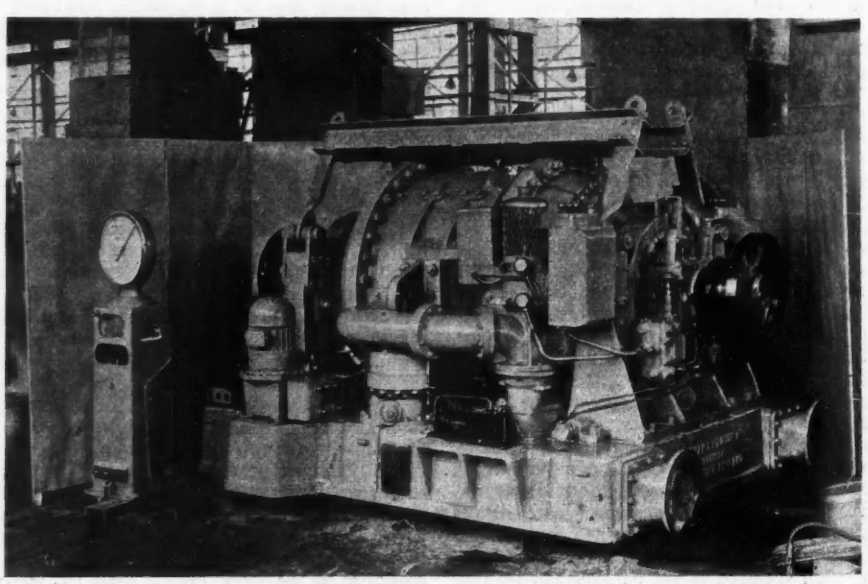
The wide and unusual combination of the powers and speeds which gas turbines, even when geared, are capable of producing, created a specification with onerous requirements which had to be fulfilled. Among other items the specification called for the dynamometer to absorb a maximum of 10,000 s.h.p. at speeds ranging from 575 to 1100 r.p.m., and the degree of reversibility required was of a more stringent nature than is common practice in the testing of marine diesel engines. This stipulation concerning reversibility called for the design arrangements to make it possible to go from a given power in one direction of rotation to the same power or some other predetermined power in the other direction within a period of time not exceeding ten seconds. A third requirement was the ability to run with the shaft raked at any angle to the horizontal up to 11 deg. Finally remote control of load and speed was necessary from a control chamber.

The first stipulation was met by a modified design of power absorbing rotor based on the conventional Froude design, which the company has developed for high-speed work. To absorb 10,000 s.h.p. at the relatively low speeds, which are generally associated with diesel engines, requires a rotor of a certain diameter and this, if used at high speeds, would result in excessive water velocities, increased rate of wear and high pressure in the rotor casing. However, modifications to the shape of the rotor have enabled the same power to be absorbed at high speed without exceeding acceptable water velocities. The method by which this has been done may be described by assuming that a tool makes a cut in the face of a normal form of rotor near the centre of the power absorbing cups so as to sever the outer periphery of the rotor from the central portion. The vanes are then removed from the annular ring, which is attached permanently to the rotor casing, while the reduced diameter rotor is fitted to the dynamometer shaft in the ordinary way. In actual practice the annular vaneless ring and rotor are separate castings, as depicted in our drawing showing the sectional elevation of the dynamometer, and the rotor diameter is governed by the capacity required while maintaining normal water velocities. We reproduce the capacity curve herewith.

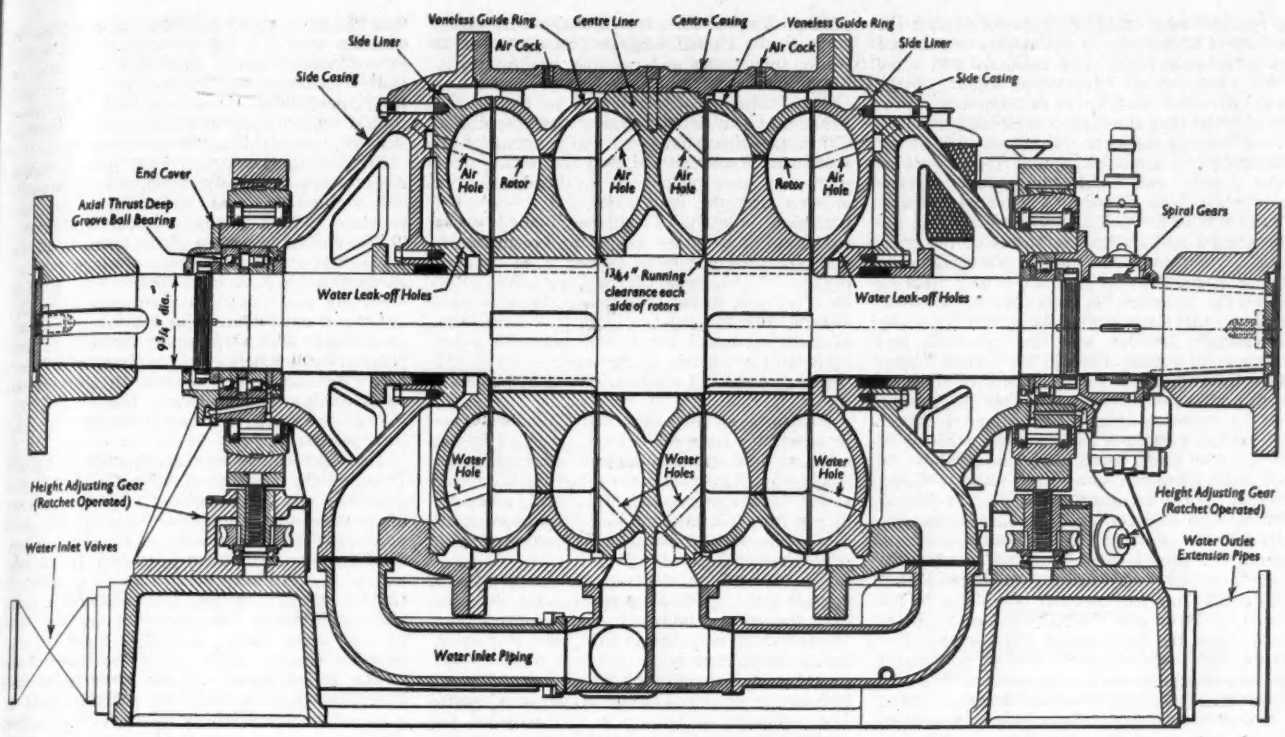
Since the gas turbine cannot be reversed it is necessary to bring it to rest before reversing the gearing, and the quicker the friction brake stops the turbine the less heat must be absorbed by the brake through the " water milling " of the propeller. The turbine is restarted after the reversing gear is engaged and is usually run up to the same speed and power as before ; hence the stipulation that the dynamometer load must be the same in either rotation. This requirement is met by the dynamometer load control system.

Normally, a single back-pressure valve controls the load absorbed in whichever of the two rotors is carrying load, and is connected to either compartment by a manually adjusted diverter valve, so that there is an infinite number of divisions of load between working and idle rotors. However, to ensure that, on the rotation being reversed, the load between the rotors was also reversed, a back-pressure valve was fitted to each compartment and a second control in the form of a needle valve was introduced in order to trim the load in the idling compartment ready for reversing. The oil pressure for operating the back-pressure valves is set up by an oil pump driven from the dynamometer shaft, so that the load/speed characteristic to the dynamometer approximates to a cubic law. Although the back-pressure valves can be adjusted to ensure that the same load will be absorbed in either direction of rotation there would be a time lag. This is avoided by the needle valve, which causes the idling compartment to retain an amount of water commensurate with the load it will be required to absorb as a working compartment after reversal has taken place. In practice the settings of the needle valve for this pre-adjustment of the load ratio between the two rotors are determined by trial and error, since great accuracy is not necessary, the main function of the valve being to reduce the time lag.

Self-aligning spherical trunnion bearing housings and extra stiff trunnion pedestals have been incorporated to allow the dynamometer to tilt to an angle of 11 deg. In addition, hydraulic torque measuring gear of the company's manufacture has been utilised to ensure that the angle of tilt will not affect the readings of the torque reaction forces. The dynamometer casing has been provided with two diametrically opposed balance arms, each connected to a piston and a constant flow of oil is circulated from one side of each piston to the other through specially shaped ports in the cylinders. Any change in the force exerted on the pistons will cause each piston to move and so change the effective area of the ports through which the oil flows. Since the flow of oil is constant the oil pressure will increase on one side of the piston so that the pressure differential across the piston is a measure of the force acting on it. Pipes lead this differential pressure to both sides of a smaller diameter receiver piston in the control room, and the final readings are given by a deadweight vernier dial weigher which resists the force exerted by the receiver piston. To avoid any loss of accuracy due to variation of oil viscosity or to friction, a small motor-driven " pulsator "



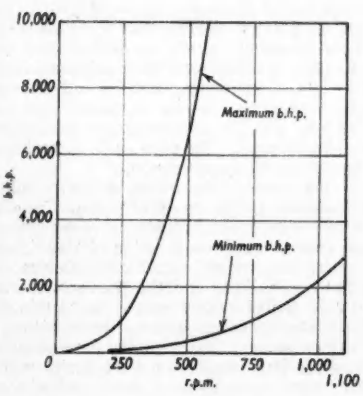
" RFA 990 " Hydraulic Dynamometer



Section Through "RFA 990" Hydraulic Dynamometer

superimposes an oscillatory pressure wave on the differential oil pressures and this has the effect of imparting great sensitiveness.

Whenever the rotation of the dynamometer is reversed the forces on the two pistons are also transposed and, to ensure that the force exerted on the receiver piston is always in the same direction, a tapping has been taken off the high-pressure side of the piston in each back-pressure valve and leads to a piston pattern change-over cock. According to the direction of rotation this piston moves to one end or the other of its travel, and in so doing the cock connects the high-pressure side of the receiver piston to the high-pressure side of each transmitter piston. The adjustment of the load is also carried out



Dynamometer B.H.P. Curves

remotely by motorising the back-pressure valves and secondary needle valves, under the control of push buttons mounted on the control panel, which is equipped with the necessary warning lights and overrun switches.

Another device permits the carrying out of governor tests and consists of a push-button-controlled, solenoid-operated valve, in either back-pressure valve, by means of which a large secondary port, communicating with both sides of the back-pressure valve piston, may be opened. This permits oil to flow with such a degree of freedom, from one side of the piston to the other, that the pressure on valve is practically nil and the valve is moved by a spring into its fully open position, which corresponds with minimum load on the dynamometer. Thus the load is suddenly thrown off and remains off until the push button is released and the dynamometer load reverts to its original amount.

The Athlone Fellowship Scheme for Canadian Engineering Graduates*

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The Athlone Fellowship Scheme

Briefly stated, the Athlone Fellowship Scheme is designed to bring to Great Britain every year thirty-eight Canadian engineering graduates for post-graduate study extending over two years. This period may be spent in industry, in a university, or it may be divided between these. This is the third year of operation of the scheme, two groups of Athlone Fellows being now in Great Britain. The scheme carries the name of a former Governor-General of Canada, the Earl of Athlone.

Before describing the Athlone Fellowship Scheme in detail it is desirable to sketch the background against which it was inaugurated.

The General Trade Aspect

Canada has a population of over 14,000,000 people. Its known natural wealth is immense and the unknown reserves may be as great. There are vast supplies of oil, mineral ores and forest products, supplementing the agricultural wealth of the country. The electrical power now available, mainly hydro-electric, equals that in use in Great Britain with a population almost four times as large. It has been said that each Canadian has at his disposal, from this power, the equivalent of the services of fourteen slaves—whose maintenance costs are low, who never strike, and who rarely fall sick.

The development of Canada is proceeding apace and the next half century should witness the rise of Canada to material greatness; nothing, it seems, can prevent this. In such a development it would be thought natural for Great Britain to play a part, notably in the supply of capital goods which Canada cannot yet produce herself and must buy. Such services would enable Great Britain to buy more Canadian mineral and agricultural produce, to the mutual advantage of both countries.

The present trade position is very much out of balance. Official figures show that in 1951 Canada exported to the United Kingdom goods worth 631 million dollars, and imported from the United Kingdom goods valued at 421 million dollars, a ratio of 3 : 2. The ratio was about 3 : 1 in the pre-war year 1938, when Great Britain took more Canadian exports than any other country. Great Britain now occupies second place to the United States in Canadian trade, the figures for 1951 being: exports from Canada to the United States, 2298 million dollars; imports from the United States by Canada, 2813 million dollars; figures which are not as excessively out of balance as those between Canada and Great Britain.

The capacity of a nation of 14,000,000 people for consumer goods must be limited, but its requirements for capital goods, particularly during a period of great development, may be very large. When the figures for the exports of machinery from the United Kingdom to the other Commonwealth nations are examined, however, it is seen (Table I) that the exports to Canada are disproportionately small compared, for example, with those to Australia.

Table I.—*Exports of Machinery and Parts Thereof from the United Kingdom to the Main Commonwealth Countries for the Years Ending December 31, 1949, 1950 and 1951*

Commonwealth country	Year ending December 31, 1949	Year ending December 31, 1950	Year ending December 31, 1951
	Value, £	Value, £	Value, £
Australia	24,126,875	33,901,939	47,618,905
India	39,017,226	36,153,894	34,389,034
Union of South Africa	22,236,806	24,964,789	32,233,706
Canada	4,970,525	9,197,625	13,380,797
New Zealand	7,422,736	9,172,271	11,250,927
Pakistan	3,356,992	5,941,743	8,124,970
Totals	101,131,160	119,332,261	146,998,339

The value of the exports to Canada is rising, year by year, but it is still lower than might be expected, when the wealth and needs of the country are considered. An increase in the exports of machinery from the United Kingdom to Canada could be of significant importance in redressing the trade position between the two countries—a point which is well appreciated in Canada.

Several trade missions from the United Kingdom have visited Canada in the post-war period to investigate the position generally and

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to consider what might be done to increase the volume of British exports to Canada. It emerged from the reports of these missions that there might well be an educational aspect to the problem which was worth investigation. It is well known that although considerable numbers of engineering graduates have come for further training to the United Kingdom from Australia, New Zealand and South Africa, relatively few have come from Canada. Canadian graduates have available to them, usually near at hand, the educational and training resources of the great republic, and a proportion of them naturally proceed there for post-graduate work. Because of this the argument has been advanced by some observers that Canadian engineers were becoming increasingly familiar with the products and resources of organisations in the United States, and, conversely, less knowledgeable of those of corresponding firms in the United Kingdom; and that anything which could be done to correct this tendency could not fail to have a beneficial effect upon trade, particularly in view of the abundant Canadian good will towards Great Britain. If the argument is accepted, it follows that in order to encourage Canadian engineering graduates to study in Great Britain some substantial inducement must be offered to offset the natural inclination to study in the United States. This matter was very carefully considered by the Board of Trade and the Commonwealth Relations Office, the Government Departments concerned, and it was decided to send an industrialist and an educationist to Canada to secure Canadian reactions to the establishment by the United Kingdom Government of a scholarship scheme, having for its object the familiarisation of Canadian engineering graduates with British industry.

Mission to Canada

Sir Arthur Fleming, a well-known industrialist with very long experience of industrial training schemes, accepted an invitation to explore this matter in Canada. He was accompanied by the author, and, during the spring of 1949, the reactions of representative Canadian organisations and individuals were obtained. An embryo scholarship scheme was discussed with Ministers and Government officers, with leaders in industry and commerce, professional engineers (representing the Engineering Institute of Canada and the provincial organisations), university representatives and with officials of trade organisations. Great help was rendered by the United Kingdom Trade Commissioners throughout Canada, and by the staff of the United Kingdom High Commission—who planned and arranged the tour. The investigation was given much publicity by the Canadian press and radio.

Reactions to the mission's proposals were usually very favourable, but occasionally approval was tempered with criticism. This sometimes came from industrialists, with memories of the interruption of supplies from the United Kingdom during the 1939–45 war, and apprehensions of further interruptions; and sometimes from university representatives, who had established close contacts with colleagues in the United States and who had sent students to them from time to time. Professorial criticism was disarmed immediately it was recognised that the suggestion was not that the flow of Canadian graduates to the United States should be deflected to Great Britain, but rather that those in control of the education of Canadian graduates should urge them to secure their advanced training with the best qualified persons or the most appropriate organisation, wherever these should be, and that, when the choice was being made, British scientists and organisations should not be overlooked or deemed to be too remote for serious consideration.

It became clear to the members of the mission that, although their proposals were sympathetically received, it would be advisable for them to try to arrange for an influential group of Canadian educationists to visit the United Kingdom, in order that they might assess for themselves the engineering potential of the country and the quality of its educational and research institutions. Government approval was immediately forthcoming to a proposal to this effect, and as a result each university was invited by the mission to nominate a representative who would come to the United Kingdom for a tour of its works, universities and research establishments. The results of this tour are mentioned later.

The British mission returned to the United Kingdom in no doubt whatever that responsible Canadian opinion favoured the inauguration of a scheme of scholarships, and that support for such a scheme would be forthcoming from industry and the universities. One leader of Canadian industry, a national figure, whose reactions were by no means to be predicted, said, after listening to an exposition of the proposals: "This project excites my admiration. Here is Great Britain, in considerable economic distress, able to take her traditional long view, planning measures which can only affect her trade ten years hence, at the earliest. I will give the scheme my full support." And he has done so.

In their many discussions with Canadian representatives the issue was always presented by the mission, quite frankly, as one concerned with Anglo-Canadian trade; the long-term economic aspect was always stressed. It is hardly necessary to say that this candour was fully appreciated by Canadians, who were equally frank in stating their reactions.

The visit of the Canadian professors was a notable event. The arrangements for the tour were the responsibility of several Government Departments, with the British Council playing the preponderant part. Active support was given by the Federation of British Industries and by the professional engineering institutions. The professors visited, in a very crowded six weeks, representative industrial firms, research organisations and ancient and modern universities. Visits to places of interest were not overlooked. At a concluding congress at the Commonwealth Relations Office the visitors gave their full support to the scheme, in the final shaping of which their advice had been freely sought and taken.

The approval of H.M. Government was subsequently forthcoming and the Athlone Fellowship Scheme was announced concurrently in Canada and the United Kingdom.

The fellowships cover: (*a*) the costs of travel from the applicant's home to his place of training, of travel within the United Kingdom as may be approved, and of the return journey; (*b*) a subsistence allowance of £6 10s. per week, net; (*c*) the cost of tuition at a university; (*d*) an allowance towards textbooks; and (*e*) a travel grant of £25 per annum for journeys within the United Kingdom. Industrial employers are asked to pay into a central fund the wages they would normally pay to a trainee of the college apprentice type. The net cost of the scheme is carried by the British Government.

The scheme is controlled by a committee, in London, representing the Government Departments concerned, industry, the universities, and the professional engineering institutions.

The Distribution of the Awards and the Method of Selection

It was decided that there should be two classes of award: one, Group A, for those about to graduate, on a quota basis; and the other, Group B, on a national basis, for those who had already graduated and were at work.

Table II.—*Group A Distribution*

	Number of fellowships
Nova Scotia Technical College, Halifax, N.S.	2
University of New Brunswick, Fredericton, N.B.	1
Laval University, Quebec, Que.	2
McGill University, Montreal, Que.	3
Ecole Polytechnique, Montreal, Que.	2
Queen's University, Kingston, Ont.	3
University of Toronto, Toronto, Ont.	5
University of Manitoba, Winnipeg, Man.	2
University of Saskatchewan, Saskatoon, Sask.	2
University of Alberta, Edmonton, Alta.	2
University of British Columbia, Vancouver, B.C.	4

The present Group A distribution, given in Table II, is based primarily on the relative numbers graduating annually in the various universities, other factors being given some weight, e.g., the desirability of having not fewer than two awards in each university (with the exception of New Brunswick).

There are arguments in favour of making the Group A selection on a nation-wide basis; that is, of selecting the best men available irrespective of university, but this perhaps ideal plan was rejected for two principal reasons: (*a*) the excessive cost of bringing together for interview in one selected centre applicants from cities as widely separated as they are in Canada; and (*b*) the desirability of ensuring that each Province should have a share of the awards in order to sustain provincial interest in the scheme.

The Group B selection is at present experimental, but, as already stated, it is nation-wide and without a quota for each university or province. This is commented upon later.

The candidates make their applications for fellowships to the university in which they are graduating (or have graduated). The A candidates are interviewed in their own university, but the B candidates, who are in practice, are interviewed in the university nearest to their place of employment (which university will have been provided with all necessary records by the applicant's parent university). The A candidates, if over numerous, are first "weeded out" by their university.

The selection boards are convened by the Dean of the Faculty of Engineering in each university and are composed of representatives of the university and of local industry, the Dean presiding. Representatives of the High Commissioner for the United Kingdom in Canada, and of the Athlone Fellowship Committee in London, assist in the selection; certain of these United Kingdom representatives are the only persons who would normally attend all the selection boards, and only they will see all the Group B applicants. If the latter were very numerous, this feature of the scheme might be regarded as unsatisfactory; it is for this reason that the Group B method of selection has been called experimental.

It has proved advantageous hitherto to have on the selection committees a representative from London able to answer the many questions from applicants as to the kinds of training available in the United Kingdom, on the answers to which often depend the applicant's decision. But this kind of advisory service will, it is thought, be less and less necessary as the scheme establishes its own traditions.

Factors Affecting the Operation of the Scheme in Canada

Many factors, some of considerable interest, have a bearing on the future success of the scheme. The more important of these will be dealt with here in the hope that they will be fully discussed.

(a) *The Emphasis on Works Training.*—It is well-established practice in Great Britain for the college graduate to enter works for a period of practical training, usually extending over two years. During this period the youth participates in a variety of manual operations and takes his place as a workman among workmen. He does not become a skilled craftsman but he acquires a good knowledge of the craft skills as well as of the general works organisation.

The fundamental aim of the Athlone Fellowship Scheme being to familiarise Canadian graduates with British industry, it is desirable to ensure that as many as possible of the Fellows shall enter industry and saturate themselves with workshop techniques and the products thereof, as do their British counterparts. But a minority of candidates so far interviewed have wished to follow this course; the majority have preferred to continue their studies in a university with a view to securing a higher degree, and of those opting for works experience some have preferred to function as observers and to spread their works periods over the maximum number of industrial activities.

(b) *Higher Degrees.*—North America is higher-degree conscious to a much greater extent than is Great Britain. The degree of M.Sc. is obtainable in many universities in the United States as the result of further studies extending over one academic year; research experience is not a necessary requirement. As a result, employers attach value to the possession of a qualification which indicates that the holder has carried his studies a little further than his fellows. Research appointments in Canada invariably call for higher degrees, usually the doctorate. In these circumstances it is not to be wondered at that the scholarship holder in Canada is tempted to use his award for the purpose of obtaining a

qualification with a definite market value. Many Athlone Fellows certainly feel this way, and it is not easy to bring them by argument to the acceptance of the alternative works training programme. If all the Athlone Fellows opted for university training, the principal purpose of the scheme would not be met unless the Fellows had substantial periods in industry during the vacations—and this is not likely to happen.

(c) *Varieties of Graduate Course.*—The Athlone Fellowship Scheme fits most suitably the requirements of the graduate in mechanical, electrical or chemical engineering. In each of these branches industrial training courses are well established and are known to be satisfactory.

In civil engineering the problem is more difficult because so much of the work which is of prime interest to Canadian engineers, e.g. water conservation and irrigation schemes, lies overseas. The rivers of Britain are well-behaved compared with many of those in Canada, and the engineer might well find the counterpart of his Canadian problem in India or Pakistan.

Similarly with the mining engineer, interested in mineral deposits, and the petroleum engineer, interested in field work ; neither can be well satisfied in the practice of their profession by experience within the confines of the United Kingdom.

Other branches of engineering are metallurgical engineering, forestry engineering and engineering physics. The latter course is one taken by many of the best of the Canadian graduates and its disciplines are severe. Men who qualify in engineering physics are well fitted for fundamental research and they are usually intent on securing higher degrees.

It is necessary, then, to ensure in the administration of the scheme the utmost flexibility and to avoid over-emphasising the value of practical work in those engineering spheres where the best of Britain's practice lies abroad.

(d) *Lack of Knowledge of the United Kingdom.*—Many Canadians spring from non-British stock and of these the largest and most homogeneous group is the French Canadian. French is the mother tongue of 29 per cent of Canadians. The teaching in the University of Montreal, and in Quebec's Laval University, is in French. In the engineering schools of these universities the most popular branches are civil and municipal, because it was in these fields that the graduate found most ready employment. French Canada is becoming heavily industrialised and the interest of the French Canadian universities in the Athlone Fellowship Scheme is intense because of the opportunities it offers French-speaking graduates to become, not only engineers with a wider training and experience, but also engineers with a good command of the English tongue, able to hold their own in English-speaking Canada.

Whereas it might be thought that the son of emigrants to Canada from European countries other than Britain might not be particularly interested in coming to Britain with a fellowship, the reverse actually appears to be the case. There is no lack of interest in Great Britain and her ways from Canada's sons, whatever their racial origin.

(e) *Employment Conditions for Graduate Engineers in Canada.*—Probably the most important single factor operating against the success of the scheme is the intense demand for graduates from all branches of the engineering industry, not only in Canada but also in the United States. High starting salaries are offered—as much as 400 dollars a month—with attractive conditions. On visiting one of the largest Canadian universities last year, the author found that he had been preceded by representatives from no fewer than fifty organisations, all anxious to earmark the best man. It requires considerable courage for a young man to put these fine opportunities aside and elect instead to accept the prospect of two years' further training under somewhat austere living conditions in a country far from home. Only those graduates able to take the long view are likely to offer themselves for fellowships. It is probable that the great bulk of the graduates with a practical bent do not apply for fellowships but seize the opportunities now presented by the buoyant industrial conditions in Canada ; and that those who do apply include many whose aim is research, for which a higher degree is a necessity. The response so far seems to support this conclusion.

The Response to the Scheme Analysed

The following figures show the distribution of Fellows between industry and the universities, and between the various branches of engineering, for the two years in which the scheme has functioned :—

	Year	
	1951–52	1952–53
Number opting for university training	12	18
Number opting for industrial training	12	9
Number opting for mixed university and industrial training	14	11
Branches of engineering in which the Fellows have graduated :		
Civil	4	9
Mechanical	8	9
Electrical	7	3
Aeronautical	2	2
Chemical	4	2
Metallurgical	3	—
Mining	1	1
Petroleum technology	—	3
Engineering physics (includes thermionics)	6	9
Engineering business	3	—
Totals	38	38

It is seen that in 1952 fewer opted for industrial training than in 1951. If this trend continues the bases of the scheme may have to be re-examined ; and a discussion upon this important matter would be welcomed. It has to be admitted that the scales are weighted in favour of the university courses ; in this option the Fellow will experience congenial surroundings, and he will have much longer holidays ; he may also secure the coveted higher degree.

Although the selection committees would, in assessing the claims of equally strong candidates, favour the one requiring industrial training, this situation in fact rarely arises. The question to be answered, then, is whether the purpose of the scheme will be achieved if the majority of the Athlone Fellows continue to prefer the university course to the industrial one.

As might be expected, the spirits of most of the Athlone Fellows are highest upon their arrival in Great Britain, and lowest a month or two later when winter makes its onslaught. The young Canadian fails to understand the British determination not to take winters seriously, and he complains of the damp coldness of British homes. He also complains of the tightness of his allowances and realises that he has to dip into his savings in order to lead a reasonable life. However, as far as his training is concerned, the concensus of opinion is one of satisfaction.

Conclusion

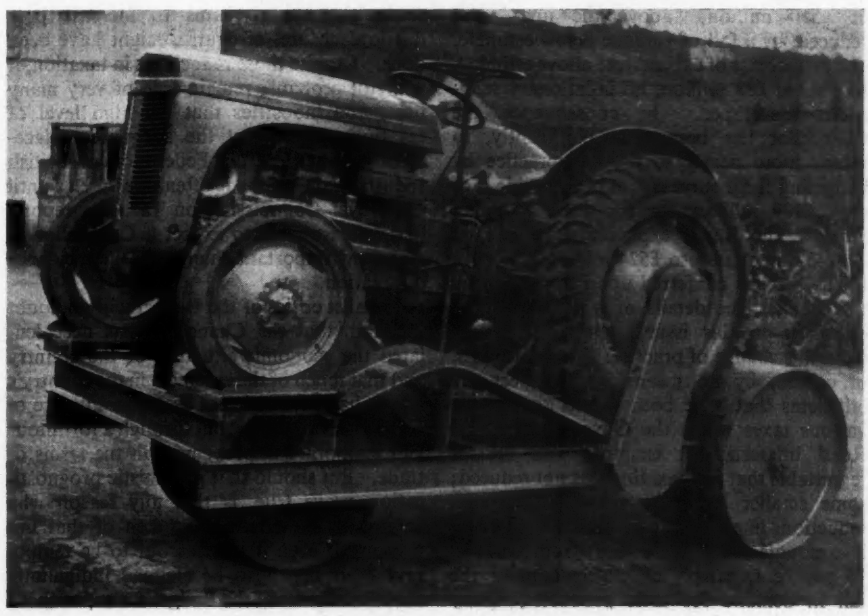
Those controlling the Athlone Fellowship Scheme are fully conscious of its possibilities, not only for improving British trade with Canada, but also for tightening the bonds between the two countries. They also realise that there are dangers that the reverse may happen. It is well known that not all of the Rhodes Scholars return as anglophiles ; and not all of the Athlone Fellows will return to Canada with an attachment to Great Britain, much as this may be desired.

The success of the scheme, as far as each individual is concerned, depends to a very large extent on the people he meets during his training —the apprentice supervisor, the foreman, the workmen themselves—and upon the people with whom he lives. Not all of these may be much concerned to send the young man home with a good opinion of Britain and its institutions. Most of the Fellows are reluctant to express themselves in writing on the treatment they receive from individuals, and when they do so corrective action is not always possible.

As far as the Athlone Fellowship Committee is concerned, they wish for nothing as much as constructive criticism from any source which has the interests of the scheme at heart. In the administration of the scheme nothing is hidden and the Committee will naturally welcome the most frank expression of views from those to whom this paper is addressed.

A Tractor-Roller Assembly

The accompanying illustration shows an ingenious method of combining a four-wheeled tractor with a road or sports ground roller, which has just been devised by E. V. Twose, Ltd., Lowman Works, Tiverton, Devon. In designing this roller the firm has had in mind the fact that borough councils, contractors and park and sports ground authorities frequently have tractors at their disposal for which there is not full employment throughout the year. In the construction of the chassis normal roller practice has been followed, there being a steering roller at the front and two driving rollers at the rear. Ramps are provided for driving the tractor on to the chassis, and, when mounted, the tractor is jacked up by its hydraulic lift so that its rear wheels are clear of the roller frame. The drive is taken by heavy duty chain to the axles of the rear rollers from sprockets bolted to the rear wheels of the tractor. Steering is effected by a heavy duty chain, the steering column for the roller being dropped into position through the steering wheel of the tractor so that any risk of confusion on the part of the operator is eliminated. The weight of the tractor—a "Ferguson" in the example illustrated—and the roller combined is 2½ tons.



A Tractor-Roller Assembly

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THE BUDGET, 1953

For the first time since the war a Chancellor of the Exchequer, presenting the national accounts before the House of Commons, has had no increased taxation to propose. It is a very encouraging change. For years past Chancellors each spring have redistributed rather than reduced taxation. What they gave in reduced taxation with one hand they clawed back by alternative taxation with the other. This year, too, the Chancellor would have been driven to that expedient had not an important decision implicit in the figures, but by no means emphatically stressed in his speech, been made. Heretofore post-war Chancellors have aimed in drawing up their Budgets to cover by revenue not only the ordinary expenditure of the Government, but also its loans to local authorities and nationalised industries and other similar "below the line" expenditure. They have done so with the object of controlling inflation. A year's experience, however, of the power of the method of monetary control, to which Mr. Butler made several references in his speech, has shown how adequate and flexible it can prove in restraining such tendencies. Despite the fact that the budgeted surplus for 1952-53 of £510 million "above the line" was reduced, by a fall of revenue below estimate, and an increase of expenditure above estimate, to a mere £88 million, no inflationary tendencies developed. In consequence the Chancellor has been able, confidently, to return more nearly to pre-war practice by budgeting for a surplus "above the line" of only £109 million, far too little to cover "below the line" expenditure, which in 1952–53 amounted to £524 million.

The benefits conferred upon the nation by this Budget, the details of which are noted elsewhere in this issue, stem very largely from this change of practice. Those benefits, of course, by no means wholly meet the criticisms that have been voiced against the various taxes which the Government levies. Road interests, for example, will find it regrettable that fuel taxation was not reduced; some smaller industries will maintain that reductions in purchase tax, particularly where it amounts only to a fall from 100 to 75 per cent, cannot effectively combat the fall in demand for their products; many industrialists would have liked to see food and housing subsidies reduced. Yet within the limited elbow room allowed him, the Chancellor has so spread the benefits that they will do much good. Above all things, this country needs to improve its productive capacity. Something can be done with existing plant by improved methods of using it. But if output is substantially to be increased and products are to be made at prices competitive in world markets, there must be more rapid re-equipment with up-to-date machinery and a greater application of power. By reinstating the system of initial allowances for capital expenditure on plant, machinery, buildings and mining works the Chancellor has given some, though a somewhat limited, encouragement to firms to re-equip themselves. Of much greater importance is his decision to end the excess profits levy as from January 1, 1954, and his proposal to reduce income tax on distributed and undistributed profits. For those changes will relieve a situation, referred to by Sir Claude Gibb in his chairman's statement at the annual general meeting of A. Reyrolle and Co., Ltd., in which the result of a firm's success in meeting the demand for increased production can be more than absorbed by additional taxation! There will, at least, be some incentive to firms to increase production. More, of course, might have been done. Despite those reductions in taxation, it will still probably remain true of very many firms and industries that the high level of taxation will prevent the adequate replacement of assets as the Federation of British Industries maintains it often does. But until the Royal Commission on Taxation reports it is unreasonable to expect a Chancellor to make any important changes in the incidence of taxation.

Socialist critics of the Budget will no doubt maintain that the Chancellor has miscalculated the economic situation of the country and that much of the easement in the country's affairs has occurred, not as a consequence of Government policies, but through a fortuitous and temporary improvement in the terms of trade. But should that pessimistic prognostication prove true, is that any reason why advantage should not be taken of that improvement even if it turns out to be temporary? It may also be claimed indignantly that the benefits of the Budget are experienced by the rich, not the poor, that some eight million people who are not liable to pay income tax receive little or no benefits. It is not true. The Budget is clearly intended to provide an incentive to increased output. Should it do so, if production goes up, so too will earnings go up and the standard of living will rise also. Indeed, the Budget should encourage hopes in all people in this country. Maybe it is true that in years subsequent to 1953-54 the ending of the Excess Profits Levy and the reinstatement of initial allowances will cost the Chancellor some £200 million more than those changes do this year, so that to that extent further reductions in taxation next year are made less likely. But at least in this year, for the first time since the war, a real beginning has been made towards easing the crushing load of taxation the people of this country bear. Yet, as the Government continues to pursue its policy of reducing expenditure and of freeing goods from rationing and price and other controls, and of using monetary controls rather than taxation to prevent inflation, it is still not impossible to hope for so large an increase in industrial production that further reduction of taxation may soon prove possible.

NUCLEAR PROPULSION

The Atomic Energy Commission and the United States naval authorities seem satisfied that the atomic power plants now being constructed for two United States submarines will fully come up to expectations, and plans are in hand for the construction of an even larger plant suitable for an aircraft carrier. Little has been heard, however, of the project, announced more than a year ago, to fly an aircraft on nuclear power, though many proposals have been made for a propulsion system. Those proposals include turbine-driven propellers, a turbo-jet, in which the reactor takes the place of combustion chambers, and a ramjet engine with similar substitution of a reactor for the combustion apparatus. In all cases, except that of the ramjet and other direct-air cycles, the heat would have to be conveyed in a coolant from the reactor to the propulsion machinery. But the problems associated with the design of a reactor for aircraft use—weight of reactor and shielding, effects of high temperature, corrosion and radiation damage—are peculiarly difficult to solve satisfactorily. The minimum weight of shielding required, for example, is estimated to lie between 50 to 100 tons, which would necessitate a very large aircraft designed to carry a great weight concentrated near one point.

Weight considerations are of less importance in a submarine and the reduction in the size of the reactor core resulting from the use of enriched uranium—containing a much larger proportion of light uranium, U 235—has made it possible satisfactorily to design a nuclear power plant for the propulsion of this type of vessel. Even so, however, the "Nautilus," the first of the two prototype submarines now being built by the Electric Boat Division of the General Dynamics Corporation at Groton, Connecticut, will have a submerged displacement of 2500 tons—a very large size for a vessel that has to be handy and readily manœuvrable when hunted by anti-submarine craft. On the other hand, she will have practically unlimited submerged range and will therefore be safe from radar detection. Indeed, unless

and until submarines of this type come within range of other detecting devices, the problem of locating them when proceeding at a speed of 20 to 25 knots at depths of 200ft or 300ft will not be easy to solve. Heat from the reactor will be taken away by a primary coolant reported to be distilled water under high pressure. This water will be pumped through a heat exchanger in which steam for driving the turbines will be generated. Steam will also run turbo-generators to generate electric current for ship use. Very great care has to be taken to remove all impurities from the primary coolant which would otherwise become radio-active. The "Nautilus" is also to be equipped with the conventional diesel, batteries and snort to provide for the temporary shutting down of the power plant for maintenance or other reasons. She is to carry her own air supply in the form of high-pressure oxygen kept in storage, and it is hoped also that a method of extracting oxygen from water now under investigation will prove successful. The most suitable chemicals for removing carbon dioxide and odours are still the subject of research and much useful information and data are expected from a trial recently carried out at Groton, when twenty volunteer seamen and a medical officer were submerged in the submarine "Haddock" for a period of two months. Both British and United States submarines have already made voyages for long periods submerged for experimental purposes—notably the U.S. "Pickerel," which remained wholly submerged throughout the voyage of 5600 miles from Hong Kong to Pearl Harbour. But in these trials there was always a continual supply of air through the snort, and they did little more than prove that men can work effectively and happily over long periods in a cramped, awkward and monotonous environment. In July last year, Congress authorised the building of a second submarine—the "Sea Wolf"—with a nuclear power plant. This vessel will be a sister ship to the "Nautilus," but will have an intermediate reactor—the neutrons producing their fissions at intermediate speeds instead of at slow speeds, as in the thermal reactor in the "Nautilus"—and the power plant will use liquid metal instead of distilled water as the primary coolant for transferring the heat from the reactor to the steam generator.

The propulsion units of both the "Nautilus" and "Sea Wolf" will, in any event, be extremely costly—1400 dollars per kilowatt equivalent and a total cost of 26,000,000 dollars are the published figures for the "Nautilus" unit. Sir John Cockcroft, in a talk given recently to the Institute of Marine Engineers, suggested as a very rough estimate that these figures would work out at about £120 per horsepower, and that, assuming a thermodynamic efficiency of 25 per cent, fuel costs would be of the nature of £30 per gramme, or 1d. per brake horsepower. Nuclear fuel costs, he believed, would be too high to make commercial units practicable for at least another decade, but, in any event, the development of nuclear propulsion for shipping would depend essentially on the supply of enriched fuel. At the end of the war the United States had large plant available for producing this fuel, but there is at present strong competition for available supplies.

Obituary

NORMAN WHINCUP

We have learned with deep regret of the death of Mr. Norman Whincup, which occurred on April 6th at Widnes, following a long period of illness. Mr. Whincup, who was sixty-three, was the technical manager of the Whitecross Company, Ltd., of Warrington, and was an acknowledged authority on steel wire ropes generally.

Norman Whincup was born at Halifax, Yorkshire, and spent the early part of his engineering career in the machine tool industry. In the first world war he was concerned with machine tool layout at the National Shell Factory at Bradford, and for a few years after the war was a partner in a machine tool business in Halifax. In 1922 Mr. Whincup joined the Whitecross Company, Ltd., and was mainly responsible for the design and layout of that firm's new ropery, which was opened in 1925. He served in the company's engineering department until 1931, and then transferred to the technical staff of the wire rope department, of which he was subsequently appointed technical manager. In that appointment he was responsible for all the technical details of the ropes produced by his firm, taking particular interest in the design and service of locked coil ropes.

Mr. Whincup was well known by his extensive knowledge of wire ropes used under all conditions, especially those used in collieries. This experience was acquired by his personal investigations at wire rope installations in this country and abroad. He served on various committees of the British Standards Institution and was the author of a number of papers and articles dealing with the technicalities of the manufacture and use of ropes. One of Mr. Whincup's articles, entitled "Wire Ropes for General Engineering Purposes," appeared in THE ENGINEER of May 26 and June 2, 1944, and for several years he had been a valued contributor on the same subject to *Kempe's Engineer's Year-Book*.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LIBRARY SERVICE FOR INDUSTRY

SIR,—What presumption is shown by Mr. Farradane in stating that if I am a librarian in possession of scientific or technical qualifications, then I must not imagine myself as just a librarian when I endeavour to carry out the duties that he appears to consider are the prerogative of an "information officer"!

He assumes, as do so many "information officers," that the ideals and duties of a librarian never go further than those practised by the staff of the average public library, and either ignores, or is woefully ignorant of, the many librarians, both in this country and abroad, who are engaged in providing highly organised and specialised information services in science, the humanities, and the arts, in many of the universities, in some of the larger national and public libraries, and in industry. Here the ideal has for many years been Mr. Farradane's "the right information to the right man at the right time," and such librarians have no need, as it appears has Mr. Farradane, to gather under their mantle such duties as those rightly belonging to publicity managers or public relations officers, in order to bolster up an argument for justifying the existence of their profession. Instances have even come to my notice where "information officers," doubtless anxious about their position, have ruled that qualified graduate librarians, serving under them, should not provide information of any kind, but should content themselves with arranging the borrowing of books, periodicals, &c.!

I have yet to find an "information officer," in the scientific and technical fields as envisaged by Mr. Farradane, who, when challenged, has succeeded in giving a definition of his duties and details of the required "outlook and techniques" (Mr. Farradane's words) that have not been almost identical with those recognised for many years as defining a research post in librarianship. All too frequently the "information officer" has to bring in "publicity," "public relations," &c., in an endeavour to maintain his position, and if anyone is in doubt about what I have just stated I would ask him to examine the files of such a publication as *Aslib Proceedings*, for articles by "information officers," when he will discover that the subjects dealt with are almost entirely in the field of librarianship.

With the ever-widening interests of industrial firms, I am convinced that the catholicity of the training in sources of information, and in the many human problems encountered in providing an efficient information service, now being given in many of the available courses in librarianship in this country and abroad, is more than necessary to those serving in scientific and industrial posts of the type under consideration. This is in addition to the requirement of previous research and industrial experience, which, as Mr. Farradane rightly points out, is of fundamental importance.

I should be the last to maintain that there is no need for improvement in library services in the fields of science and technology, but what we must strive for is surely not the creation of a new profession, but a constant endeavour to make sure that librarianship, starting as it does on a sound foundation and embodying most of the principles so admirably stated by Mr. Farradane, should demand from its practitioners even higher standards of training, qualification, and service.

D. V. ARNOLD

Ealing, London, W.5,
April 12th.

SIR,—I should like, as an information officer, to congratulate Mr. J. Farradane for his admirable clarification of the issue between the librarians and the information officers in his reply which appears in your issue of April 10th. The fact that we have two such distinctive groups of experts in the general field of information dissemination clearly indicates two separate functions. Mr. Farradane hits the nail on the head when he states that "information officers are only *experienced* users of libraries" (italics mine). From the librarian's point of view this must imply a limitation of the librarian's proper function. This need not, however, detract from the status of the information officer in the field of industry where he mainly practises his art.

It is worth while remembering that the information officer has appeared in industry in direct response to a felt want. Owing to industry's increasing need of vital information from a wide range of sources, the specialist emerged. What more natural than that he should be an individual having a thorough acquaintance with the firm's specialised requirements. It is important to realise that, because the information officer is a relatively modern member of the industrial team, his training is certainly liable to modification and, in the future, will probably result in the appropriate professional qualification. One thing is certain—if the information officer of the future has to receive the basic training of the librarian, he must, in common with other professional members of industry, have, at the same time, a technological background.

S. C. MCKENZIE

Rugby, Warwickshire,
April 13th.

Literature

The Farmer's Tools, 1500–1900. By G. E. FUSSELL. London: Andrew Melrose, Stratford Place, W.1. Price £2 2s.

AGRICULTURAL machinery to-day constitutes an increasingly important part of this country's engineering output. Its design and development demand the careful study of engineers, and are matters in which farmers are now taking much more than a passing interest. The system of power haulage provided by the tractor has certainly given engineers greater scope in designing farm machinery, but any consideration of modern farm equipment nearly always revives recollection of the implements—many of them cumbersome and crude—which were used when farming was a much more laborious business than it is now.

In this book Mr. Fussell has presented an admirable survey of British farm implements, tools and machinery between the years 1500 and 1900, or, as he puts it, "the years before the tractor came." The material has been arranged to follow the cycle of the farming year from seed-time to harvest, the book recording the progress made in improving the implements and machines used for each season's work during the four centuries discussed. Naturally, the quantity of implements and machinery dealt with is vast. It includes draining tools, ploughs, harrows (an example of which, dated 1808, was known as a "tormentor"), cultivators, drills, grass mowers and hay-making machinery, corn reapers, threshers, root cutters and grinding mills, and—as the last century ended—potato diggers and planters, and milking machines. All through the book the author has been consistent in defining an "implement" as something inert, having no internal working parts, and a "machine" as something that has moving parts within itself essential to its operation.

The factory production of implements and machines did not become general until well into the nineteenth century, a century in which there was no lack of inventions directed to the fuller mechanisation of agriculture. Thus, the book gives some account of several implements and machines which did not get much beyond the prototype stage. They appeared at a time when farmers were stubbornly opposed to new-fangled devices. But the basic principle of some of those devices has been applied a hundred years later! The book records, for example, how in 1839 a man named Grounsell produced a drill with a spacing mechanism designed to drop seed and manure at intervals and not in a continuous stream. An iron ring, with a series of holes in which studs could be fixed, was fitted to the inside of one of the ground wheels. The studs acted as a striking mechanism, and as the wheel revolved they opened valves for the delivery of the seed and manure, the valve closing again directly the stud had passed.

The application of steam power to agriculture is aptly described by Mr. Fussell as the "first phase of farm mechanisation." His treatment of that phase and of the implements and machines resulting from it is particularly interesting. With the introduction, a few years ago, of the hydraulic power lift, tractor-mounted implements and machines of many kinds have come into general use in this country; they are still a recent development. But the book recalls that in the early days of steam power on the land there was at least one attempt to introduce the principle of the front-mounted machine. It was the attachment of a Crosskill reaper, giving a cutting width of 11ft or 12ft, to the front of an Aveling and Porter 8 h.p. traction engine carrying a crane. This "steam reaper" took part in the Royal Agricultural Society's competitive trials in 1876, and for its performance Aveling and Porter received a gold medal. Briefly, the method of attachment was by hooking the crane chain into the bight of a second chain, which was secured at each end to the frame of the reaper. Turning the machine at the ends of the field was simple. The crane was set in motion and the reaper was lifted above the standing crop. The traction engine was then turned round and the reaper again lowered into position on the ground for the next length of work. Mr. Fussell says that this "massive steam-hauled machine did not come to anything" although at the trials it "pushed its way about the field in what was thought a most extraordinary manner, delivering a swath so perfect as to surprise most of the spectators and delight all."

The book is certainly one of those with which engineers and laymen, too, can spend many an instructive and entertaining hour. Its illustrations have been carefully selected and well reproduced, and, like the text, indicate clearly much of the road that has been travelled by inventors, designers and manufacturers in the progressive development and improvement of farm implements and machines.

Across the Space Frontier. Edited by CORNELIUS RYAN. London: Sidgwick and Jackson, Ltd., 44, Museum Street, W.C.1. Price 21s.

IT is now generally accepted that the setting up of an artificial satellite of this earth must be the first step towards the ultimate realisation of space flight and that the manned space station, acting as a refuelling station, will probably be the stepping stone for interplanetary flight. This book is an expanded version of a symposium which appeared in *Collier's Magazine* and is interesting in that several authors describe the many aspects of the plans of a well-known rocket engineer, Dr. von Braun, who was in charge of Peenemunde during the war, where he produced the V-2 rocket. His prophecies on how space travel is likely to be accomplished must bear serious consideration.

The story told in this book is certainly fascinating. But whether it has any close relation to ultimate reality is another matter. Close study of the book, for instance, shows that in addition to the prodigious cost of the venture there are many serious practical doubts which must spring to the mind of engineers. In the first instance, only very sketchy details are given of the mighty rockets needed for the assembly of the station in space. They are rather gigantic vehicles weighing some 7000 tons at take-off and no mention is made of the stressing for the immense inertial loads which will be experienced during the take-off accelerations, which are calculated to reach a peak of eight or nine times that of gravity. The large propellant tanks are illustrated devoid of any apparent structural members, and one cannot understand why the principle of expendable construction, which should considerably aid the fabrication of large rockets, is not mentioned. It is, moreover, really very difficult to visualise rocket ships of more than 500 to 600 tons take-off weight being constructed for some very considerable time to come, whereas the project outlined in the book necessitates an estimated four firings a day of 7000-ton rockets for a period of several days during the construction of the station! Nor is that all. When the station has been assembled in its orbit, 1075 miles above the surface of the earth, the crew of eighty men need air, water and food, and regular changes in personnel. The result is that the launching of great rocket ships must then continue indefinitely with a frequency of two per week. In fact, the construction of the ambitious 250ft diameter wheel-shaped space station, capable of accommodating eighty crewmen envisaged in the book, seems quite unnecessary as a first step, and certainly impracticable as such a step. A much smaller station and complement of personnel could probably do identical work and eliminate this awe-inspiring procession of giant rockets ascending to the orbit. A peculiar omission from the calculations has been that relating to the benefit to be gained from the earth's spin in reducing the take-off mass. It looks as though this omission is the consequence of a questionable desire to use the space station for military observations and the resultant choice of the uneconomical polar orbit. On the other hand, an orbit inclined at a moderate angle to the equator could utilise at least some of the earth's peripheral speed for propellant conservation, and yet allow observation of vast tracts of the earth's surface and, moreover, be of use in any subsequent journey to the moon or into interplanetary space. Some interesting transportation problems are posed, including the idea of carrying a 100in telescope mirror to the orbit and the disposal of refuse from the station in a way that will not interfere with observations. There are also some details of the environmental difficulties which man will meet in space with suggestions for overcoming them.

This is a readable book. But engineers cannot be expected to take a serious interest in it. That an unmanned, but scientifically equipped, artificial satellite of very modest proportions might be set up is so nearly a practical proposition that it is worth the while of engineers to make preparatory studies of the problems involved. These problems, however, are quite difficult enough without complicating them still further by assuming the satellite is to be manned by some eighty odd people! For before any really useful work can be done on the study of so large a project a great deal of hard, practical, experimental knowledge has yet to be gained. At present, that practical knowledge, as opposed to sheer theory, does not exist. In consequence, engineers have nothing on which to base an opinion whether the great project described in this book has any real relevance to future developments or whether it is largely fantasy. Most of them will be quite content for many years to come to study the detailed technicalities of the design of the earth-bound rockets, though many will feel confident that that study will, in the not distant future, make practicable a modest project for the setting up of an artificial satellite. There will be time enough thereafter to study more ambitious projects and much better factual material, gained by experience, will be available upon which to base designs.

BOOKS RECEIVED

A History of Civil Engineering. By Hans Straub. London: Leonard Hill, Ltd., 9, Eden Street, N.W.1. Price 25s.

Elasticity in Engineering. By Ernest E. Sechler, London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 68s.

The Agricultural Tractor. By P. H. Southwell. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 15s.

The Athlone Fellowship Scheme

No. I

At a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers, last Friday, April 10th, a paper entitled "The Athlone Fellowship Scheme for the Practical Training in Industry of Canadian Engineering Graduates in Great Britain," by W. Abbott, C.M.G., O.B.E., Ph.D., B.Sc. (Eng.), M.I.Mech.E., was discussed. The paper is reprinted on page 561 of this issue.

Discussion

Professor A. J. Sutton Pippard said that a large number of the Athlone Fellows were coming to Imperial College, and at the present moment twenty-five out of the seventy-eight Fellows coming to this country during the first two years had joined Imperial College, and of these eight had entered the Department of Civil Engineering. He thought it was of paramount importance to resolve the doubts expressed in the paper—and perhaps some of them had been resolved by this year's selection—doubts which he thought were shared by many of them—as to the relative importance of providing post-graduate study and practical experience for the Athlone Fellows. His own personal view was that, while emphasis must be laid on the practical training since that was the main object of the scheme, he quite naturally hoped that many of the really suitable men would be allowed in the future, as they had done in the past two years, to spend the whole period in the universities. He wanted to make it clear that he emphasised the need for the practical training, but he felt that there were some Fellows who would do better in the universities for the two years. The second point he wished to raise referred to the stressing of the long-term economic aspect in relation to Anglo-Canadian trade. This was certainly the object in the minds of the initiators of the scheme and to that extent it was important, but his own feeling was that it would be a fundamental mistake to allow the trade aspect to occupy too much space in their thoughts, and he would plead that they should give the young men coming to this country from Canada the very best education and training that they could provide without considering the ulterior motives. If they were successful in doing this, they would undoubtedly automatically achieve the original object; if they failed to do it, the scheme would not be saved by any amount of emphasis laid on its commercial importance.

He now turned for a moment or two to the remark made in the paper that the problem presented by Civil Engineering Fellows was more difficult than for others because so much of the work which was of prime interest to Canadian civil engineers lay overseas. This statement, of course, was true as far as it went, but he would remind them that it was not only post-graduate education in water conservation and irrigation—mentioned in the paper—which this country had to offer. They could provide instruction in the theory and design of all types of structures, in soil mechanics, in public health engineering, in hydro power, and in many other branches of civil engineering, and even assuming that most of the work was to be found overseas, he would remind them that British civil engineers were still responsible for designing and carrying out a great deal of that overseas construction. The design work was done here in London for a great deal of it, and was carried out by British firms. Students in his own laboratories, for example, would at any time see research and experimental work being done for direct application in a wide variety of projects which were being carried out in many different countries. This was part of the usual work of the laboratories.

In many cases the men selected were somewhat immature academically and from a professional point of view. They had generally come straight from the university where they had taken an initial bachelor's degree in order to start post-graduate studies in this country. He thought it would be generally agreed that the Honours Degree in Engineering of a British university at present was somewhere about the same standard as the Master's Degree in the United States and Canada; and so it followed that men from North America who had just obtained a Bachelor's Degree were not quite up to the standard of most of the British graduates, especially in their ability to work without constant supervision—which he thought was important. He had had reports from members of his own department quite independently, and they had almost unanimously reported that many of the men would have done better to take the third-year course rather than to start on post-graduate studies at once. There were, of course, very notable exceptions. Was there any way of improving the position and making what was already a good scheme a really excellent one? He thought that resolution of the doubts as to the proper balance between study and practical training and also the problems raised by the immaturity of some of the Fellows reduced to the simple question of finance, and he would say categorically that the emoluments of the Fellowships were not, in general, adequate to attract sufficient of the people whom they would all like to have. He therefore suggested that they would serve the ideals of the scheme better for the same total outlay—he would like to see the outlay doubled—if the number of bursaries were halved and their value doubled.

Mr. K. R. Evans believed that the two-year period in industry was about the right time, but that the content and the intensity of learning and instruction during those two years could probably be increased. The best possible use must be made of that time. Another point he wished to raise related to the question of the one year's release. Did Dr. Abbott mean that the men should come to this country and specialise on one product, or did he mean that, in some mysterious and wonderful way, the variety of products, functions and training which were common for a graduate in this country should be achieved in one year? He did not think that Dr. Abbott meant this. But if (and he considered it was very practicable) industry was to absorb people for one year who had had some years in industry in Canada, it was essential that they should be reconciled—and he used that word deliberately—to getting down to a short period in the basic shop processes. It was his personal opinion that it was not fair to expect a young man to come into a design office, not being familiar with the actual product and the manufacture of it in this country, and to ask questions morning, noon and night of a highly-paid experienced engineer to whom he was attached, who was busily engaged in doing his normal job and who would be pestered (perhaps that was too strong a term and he should say "worried") with the need for giving his attention to the young man for months of time. The young man could so easily gain for himself the experience which would make those questions unnecessary, and he would then be much more welcomed by the engineer on the job. The engineer would be only too glad to teach the young man all he knew if only that young man had just a modicum of specialised knowledge of that product before the engineer was asked to teach him.

Mr. R. M. Wynne Edwards quite disagreed with the author's note in the paper about water conservation and irrigation schemes being Canada's chief interest. Canada was interested in exactly the same sort of things as this country so far as the young men were concerned, and those things could be got in this country just as well as in Canada. From a civil engineering point of view he did not think that it mattered whether men went to a university and took a higher degree there, or whether they went into industry, because they would meet the same kind of people in both places. He thought it was very important indeed that the university staff should make it their business to see that the young men really got into all things and did not just drift in some dim orbit outside. It was important that the young men should be shown what they could learn, what they could see and what they could get in this country. That was up to the university staff. On the question of working outside, it occurred to him that there were quite a number of British contracting firms (and he spoke as a contractor) who had affiliations in Canada or were seeking affiliations there, and he thought that they could be fairly readily persuaded to train young men in just the same way as the graduates from college were trained in this country. Again, he emphasised that they would be trained in all kinds of basic engineering such as they would learn anywhere, so there would be nothing lost so far as the Canadians were concerned. The idea about having older men might very well be even more attractive to contractors. He had dreamed for years about getting some good Canadians over here to wake up the industry in this country. He thought this would be splendid and most attractive, and he was all for the idea.

Mr. F. R. Livock felt that to some extent the Athlone Fellowship Scheme had tended to get away from the original purpose as he had understood it. The original purpose had been to offer practical training scholarships. He had been delighted to see (and how it had been achieved he would rather like to know) the swing back to industry on the part of the candidates coming to Great Britain this year. Despite the industrial potential, one could not help feeling that the wholehearted support and enthusiasm of Canadian industrialists might not yet have been aroused. How could that be done? He would like to mention the experience he had had in going out to Latin America last year with Sir Arthur Fleming, who did all the pioneering work in these schemes. He had gone to Latin America with Sir Arthur Fleming with the object of making known the Federation of British Industries' scholarships which were available to graduate engineers so that they could come to this country for practical training. It had been found that, apart from the demand for the normal type of scholarships for the newly graduated engineer, there was a very real need for specialised experience, and in consequence the F.B.I. scholarships were now in three forms. The third form he would not bother to mention, because it was comparable to the mixed scholarships under the Athlone

Fellowship Scheme. The form which was of interest was the scholarship which was available to young men—or not necessarily young men—who had had some years of experience in industry and who wanted to come to this country for specialised training of short duration. These scholarships would therefore be made available possibly for only a period of six months ; a man might want some specialised knowledge which could quite readily be given to him in a period of six months. The scholarships under the scheme were being made available for short periods, and it would be appreciated that that fact meant a higher rate of remuneration.

Mr. A. S. Quartermaine said that in the paper it was very clearly pointed out that the origin of the scheme had been to give practical training. That intention and object must not be forgotten. If they were to get the benefit of improved Anglo-Canadian trade as a result of the scheme, then it was desirable to get the major number of Fellows into industry. He could not help feeling that they were weighting the scales a little on the side of the man who went into the university. If he understood the scheme properly the man who went into industry got £350 a year or thereabouts, plus his free passage and £25, and so on. The man who went into the university got all that, plus his tuition free. He felt that if they wanted the young men to go into industry, then what the Government saved in university tuition fees might well be paid to the man who went into industry, particularly as the Government received from the industry the amount that the industry would otherwise pay in apprenticeship wages.

It had been mentioned that civil engineering—and he spoke as a civil engineer—was not quite the class of engineering that was sufficiently well catered for in this country for, say, an Athlone Fellow. He wished to cross swords with the author on that point. Canadian civil engineering was on a big scale. For instance, the new power station at Niagara—the second one that was going up—was a 100,000,000 dollar scheme, with over 1,000,000 h.p. output, and two tunnels, each 5¼ miles long and 50ft diameter. That was pretty big stuff. It might be thought that it put the hydro-electric schemes in Scotland in a category that was not worth looking at, but that was not so. The schemes in Scotland were very varied in design and methods of construction and there were scores of miles of tunnels 15ft and 20ft diameter being constructed there. In other directions, he supposed that there was no finer Tube Underground system than there was in this country. The London water supply, for variety and quality, wanted a bit of beating. Then there were the sewage disposal, the airports and the docks. London Docks and particularly—for the benefit of their American friends, one or two of whom were present—the ocean terminal at Southampton might be thought of as something worthy of consideration by civil engineers from Canada who wanted to equip themselves in the best possible way to develop the vast resources of that country.

(*To be continued*)

The Physical Society's Exhibition

No. II—(*Continued from page 540, April 10th*)

THE thirty-seventh exhibition of scientific instruments and apparatus arranged by the Physical Society was opened on Monday, April 13th at Imperial College, Imperial Institute Road, South Kensington, W.7, and closes at 5 p.m. to-day, April 17th.

A further selection of exhibits is briefly described herewith.

Telegraph Construction and Maintenance Company, Ltd.

The exhibits shown by the Telegraph Construction and Maintenance Company, Ltd., Telcon Works, Greenwich, London, S.E.20, exemplify some of the recent work done by the company's metals division on the properties of soft magnetic alloys.

Among the aspects of this work covered by the exhibits are the effect of mechanical strains on the differential susceptibility loop ; the study of loss curves up to 500 c/s ; the growth of large crystals of nickel irons ; the determination of the surface relating magnetic flux, field and temperature for a 30/70 nickel iron shunt alloy, and the correlation of the magnetic and mechanical properties of iron-cobalt alloys.

The company's work on spring alloys includes investigations of beryllium-copper alloys, leading to the development of the 2 per cent hardenable alloy. Another exhibit on the same stand concerns the extension of the range of thermostatic bimetals to include trimetals and materials with enhanced resistance to corrosion.

Department of Scientific and Industrial Research

Various research stations of the D.S.I.R. are sharing a stand ; they include the Building Research Station, the Chemical Research Laboratory, the Fuel Research Station, the Hydraulics Research Station, the Mechanical Engineering Research Laboratory, the National Physical Laboratory, and the Radio Research Station.

The Fuel Research Station is showing equipment for extending the range of a recording potentiometer, which has been developed for use with fine thermo-couples to measure vapour temperatures over a wide range in fractionating columns. Using the equipment exhibited the range of a six-channel recording potentiometer can be increased sixfold. To achieve this a number of standardised back e.m.f.s taken from a potential dividing network are automatically injected through uniselector switches into each of the thermo-couple circuits. Thus the resultant e.m.f. is limited to the recorder range and a thermo-couple with its cold junction maintained at 45 deg. Cent. will record non-decreasing temperatures from −10 deg. to +270 deg. Cent. in six separate traces.

The Mechanical Engineering Research Laboratory is showing a portable gear-tooth profile recorder which can be used to measure the profiles of spur and helical gears from 30in to 200in diameter. It consists of a base plate which can be accurately aligned on the gear under test and a measuring unit incorporating a precision lever mechanism. A trace is made at a magnification of ten on a smoked glass plate to record the magnitude and form of the errors in tooth profile relative to a straight-line datum. By optical enlargement of the trace a final magnification of 500 is attained.

The National Physical Laboratory is illustrating the application of the Merton nut in precision measurement. The principle, which is due to Sir Thomas Merton, is that a rotating cylinder with a screw thread of 1000 or more threads to the inch will impart linear motion free from periodic error to a nut lined with soft plastic material such as pitch. There are many useful applications in metrology. For example, in the production of precision scales on glass the reduced image of a long, fine slit is repeatedly projected by a flashing lamp on to a photographic plate continuously advanced by a Merton nut. The flashes are timed by the rotation of the nut and in this way accurate scales of 5000 divisions per inch or any sub-multiple thereof can be produced. By applying the Merton nut directly to a rotating table a uniform circular motion, free from periodic errors, can be obtained ; a drive of this kind is particularly suitable for the prism tables of spectrometers.

The N.P.L. is also showing how a commercial punched card unit has been adapted to operate a standard commercial electric typewriter. This equipment was developed to provide a typewritten record of the decimal-number punch-card output of the N.P.L. automatic electronic digital computer.

The Radio Research Station is exhibiting apparatus for the measurement of fluctuation noise in germanium rectifiers at very low frequencies. The apparatus is a compact amplifier with five switched resonant frequencies having a Q-factor of about 1. This amplifier serves as a selective element in the equipment for recording rectifier noise. The rectifier, which is carrying current in the reverse direction, is coupled through a d.c. amplifier to a Schneider circuit feeding a cathode follower which drives a pen recorder.

Salford Electrical Instruments, Ltd.

A self-contained a.c. load analyser for the measurement of current, voltage, power and power factor in single-phase and polyphase power circuits is one of the new instruments shown by Salford Electrical Instruments, Ltd., of Peel Works, Silk Street, Salford, 3, Lancs.

As illustrated in Fig. 7, the analyser is a portable test set consisting of four 3½in dial instruments with 7½in scales, the appropriate current transformers, resistances, chokes and switches being mounted in a polished teak case fitted with a leather carrying handle. The

Fig. 7—Load Analyser—Salford

instruments fitted are an ammeter, a voltmeter, a double-element induction wattmeter and a three-phase unbalanced-load power factor meter, placed close together to permit accurate simultaneous readings. Three switches are provided : one to change the voltage range, another to insert the voltmeter in each phase, and a third to insert the ammeter in each phase.

The ranges covered by the instrument are 5A, 25A and 125A, 150V, 300V and 600V and from 1kW to 100kW. The accuracy in voltage and current is 1 per cent of full scale and in power 2 per cent of full scale. The power factor meter gives an accuracy of 2 deg. of phase between 1 and 0·5 power factor.

In testing single-, two- and three-phase apparatus, such as motors, transformers and generators, the instrument may be connected in the lines at a junction or terminal box or at a fuse board. The connections are reduced to a maximum of three to the supply and three to the load by virtue of the permanent internal wiring. Thus, when checking an installation, time is saved in making complex connections to the individual instruments. All the essential informa-

tion on an a.c. circuit is given instantaneously and fault finding in industrial networks and analysis for power factor correction is greatly reduced.

Eversheд and Vignoles, Ltd.

To eliminate the inherent limitations of hand-operated insulation testers, Eversheд and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.4, have developed a high-voltage mains-operated "Megger." In this instrument (Fig. 8) the hand-operated generator of the "Megger" has been replaced by a static rectifier operating from a.c. mains through a step-up transformer. The instrument movement itself is of similar pivoted construction to that of the hand-driven "Megger." The new test set is particularly useful in tests which involve the application of a high voltage for periods up to half an hour or more—conditions which are evidently outside the scope of a hand-driven instrument.

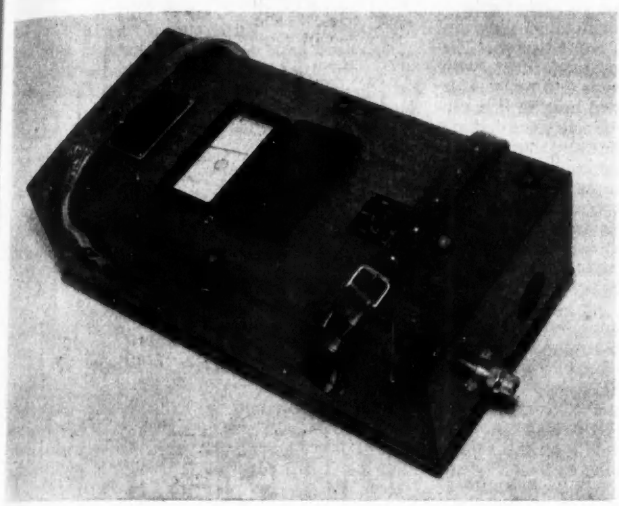


Fig. 8—Mains Operated High Voltage Insulation Test Set—Eversheд and Vignoles

To increase the useful range of the instrument it has been designed to be suitable for three testing voltages, namely, 5000V, 2500V and 1000V. Two megohm ranges are provided for each voltage and selection of the appropriate voltage and megohm range is made through a six-position scale switch mounted on top of the instrument.

Like the "Megger" insulation testers, Series 1, the new instrument incorporates a double scale, both scales being calibrated to read directly on the 5000V range. The outer scale reads from 30 to 100,000 megohms and the inner scale from zero to 500 megohms. When tests are being made at 2500V or 1000V the readings on either of the megohm scales are divided by two and five respectively.

To protect the operator from shock an automatic switch is embodied in the instrument: when the mains supply is switched off this switch disconnects the test terminals from the instrument and short circuits them, thereby discharging the capacitance. As a further safeguard a red pilot light is fitted on the top of the instrument case to indicate whether the set is "alive."

The British Thomson-Houston Company, Ltd.

A demonstration given by the British Thomson-Houston Company, Ltd., Rugby, shows how a high-speed, multiple preselecting batch counter can be applied to the cutting of wood veneer in predetermined lengths.

In this equipment a circular disc with sixty holes spaced evenly around its periphery is driven from the veneer (represented by a paper tape in this particular demonstration). The design is such that for every 0·1in of movement of the tape a beam of light falling on a photo-cell is interrupted. The signal from the photo-cell is fed to the batch counter which consists, essentially, of four dekatron counting tubes arranged to operate in cascade so that the first tube counts tenths of an inch, the second counts inches, and so on. Counting continues until the glow in all four dekatrons reaches the predetermined cathodes—that is, until the batch figure is reached. Then the veneer is stopped and cut off, the counter is reset and the next length is dealt with.

By depressing the appropriate push button on the control unit any one of ten preselected lengths can be chosen, and a change can be made instantly by pressing another button. For example, if, during the measuring off of a 60in length, a blemish is noted somewhere within, say, the last 12in, the operator can press the "48" button and cause a 48in length to be cut off, discarding the portion containing the fault.

Since the maximum rate of counting of the dekatrons is 2000 per second, the maximum rate of measuring would be 200in per second, which is far in advance of the practical limit of about 12in per second imposed by the requirements for handling the veneer.

Another B.T.H. demonstration shows a beam analogue designed for the determination of the critical speeds of rotating shafts. In this apparatus the shaft is represented by a thin piece of piano wire gripped in arms pivoted about a horizontal axis in such a way that the distance from the wire to the axis is proportional to the stiffness of the shaft, the piano wire being below the axis. Arms representing the shaft bearings are clamped rigidly in a vertical position. Loading of the shaft is represented by weights on the appropriate arm, the weight being proportional to the shaft load at that point.

With this arrangement a small deflection of the wire causes a lateral force in the same direction as the deflection and proportional to it, and to the shaft loading. This condition corresponds exactly to that pertaining to a rotating shaft where the deflecting forces are proportional to the product of deflection, shaft loading and the square of the angular velocity. Thus, for a perfectly balanced shaft deflections are stable only at the critical speed. To use the analogue therefore the weights on the arms are raised until the piano wire and arms are in neutral equilibrium, when the distance from the weights to the axis is proportional to the critical speed. The analogue can be extended to include shafts with elastic supports, by loading the supporting arms below the axis, the loads being proportional to the elastic constant of the support.

General Electric Company, Ltd.

Among the exhibits shown by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, is a self-balancing Wheatstone bridge designed primarily for converting the resistance of a platinum resistance thermometer into a ten-digit binary code for transmission over a communication channel.

Resistances, arranged in the binary scale of values, are switched in or out of the balance arm of the bridge by a ten-stage reversible relay-type binary counter. The bridge is supplied from a 500 c/s oscillator and the bridge output is fed through an amplifier to a phase-sensitive detector operating a centre-stable telegraph relay. When the balance is upset this relay instructs the binary counter to count up or down until balance is restored. The binary code corresponding to the thermometer resistance is displayed on an indicator comprising ten neon lamps. Each step of the binary counter represents about 0·1 deg. Cent. temperature change. The bridge will follow a change of 1·0 deg. Cent. per second.

An electronic binary-to-decimal converter is also exhibited; it facilitates changing from the ten-digit binary number display on the bridge indicator to the more familiar decimal scale.

Another new exhibit on this stand is a vector slide rule designed to simplify the analysis of a.c. networks and the multiplication and division of complex transfer functions. One application of the slide rule is in the conversion of the parameters of a complex quantity in either orthogonal or polar co-ordinates. Quadratic and linear additions and subtractions can be done, together with the usual slide rule operations.

The Plessey Company, Ltd.

An exhibit of interest to electronic engineers is the high-gain selective amplifier shown by the Plessey Company, Ltd., Ilford, Essex. It is intended for use, in conjunction with a crystal detector, for the detection, comparison and measurement of low-level modulated r.f. voltages.

The amplifier (Fig. 9) has two independent input sockets and gain controls which are selected by a switch fitted directly above the input sockets on the front panel. The mid-position of this switch connects a 200 k-ohm resistor from the input grid to earth, thus giving an indication of the noise generated with this input impedance. A calibrated attenuator and a fine gain control, which are common to both inputs, are also included.

The instrument may be used as a selective or wide band amplifier. In the former case it may be tuned over the band 300 c/s to 6 kc/s by the frequency control. Its maximum sensitivities are not less than 1·6μV in selective, and not less than 4μV in wide band condition, in each case for full-scale deflection on the meter. Output sockets are provided for a cathode-ray oscilloscope and external meter which must be connected into circuit by means of the meter switch.

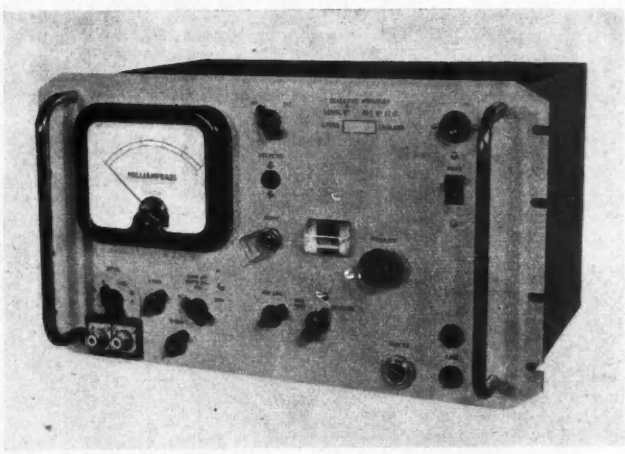


Fig. 9—High Gain Selective Amplifier—Plessey

This company is also exhibiting a precision revolution counter, whereby the angular velocity of the required rotating member is determined by taking a frequency output from the member. A 4 kc/s crystal frequency standard is used to control a divider chain giving a one-second timing standard, and the frequency to be counted is applied to a cold cathode decade counter via a gate controlled by this time. The accuracy attainable is stated to be 0·1 per cent.

(To be continued)

A 70 B.H.P. Four-Cylinder Petrol Engine

A FOUR-CYLINDER petrol engine, designed specifically for 2-ton and 3-ton "Thames" vehicles, is now in quantity production at the Dagenham works of the Ford Motor Company, Ltd. It is an o.h.v. engine of 3610 cubic centimetres capacity with a bore of 100mm and a stroke of 115mm. It exhibits a notably flat torque characteristic, maintaining over 160 lb-ft between 1000 and 19,000 r.p.m. and developing 165 lb-ft at 1500 r.p.m. The maximum b.m.e.p. also at 1500 r.p.m. is 113 lb per square inch and the maximum b.h.p. of 70 is developed at 2800 r.p.m.

The combustion chambers in the cast iron cylinder head are wedge shaped, as can be seen in our sectional drawing. The replaceable exhaust valve seats are made of molybdenum-chrome alloy steel and adequate passages have been provided for the water flow round both the exhaust valve guides and the sparking plug bosses. Seventeen high-tensile bolts are used to hold the head down and prevent distortion. The camshaft, which has replaceable end thrust washers and runs in five bearings, thereby minimising shaft whip at higher engine speeds, operates the overhead valves through mushroom tappets, hardened steel pushrods and rockers, pressure-fed with oil through the hollow shaft, which is supported on five brackets. The rockers are drilled to supply oil to the wiping faces and valve clearance settings are made by means of adjusting screws and locknuts at the pushrod ends.

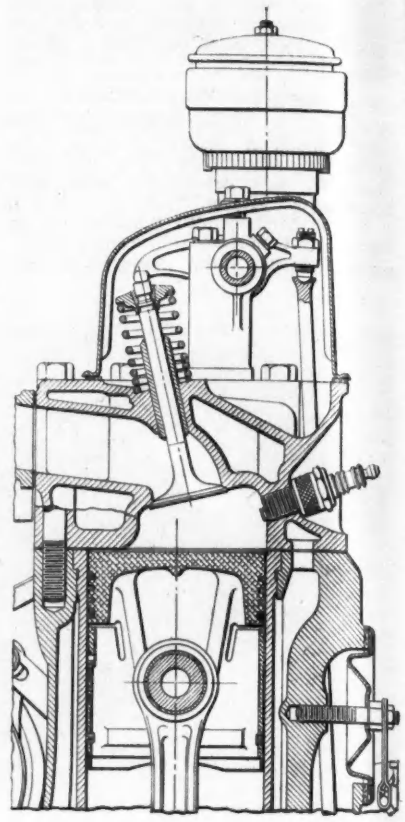
The cylinder block and flywheel housing is cast integrally with the upper half of the crankcase. Full-flow wet cylinder liners of centrifugally cast alloy iron are positively located top and bottom in the block and are easily replaceable.

The pistons are made of aluminium alloy tin-plated with tapered and cam ground skirts. The forged steel connecting-rods are fitted with bronze bushes in the small ends and replaceable steel-backed lead-indium plated bearing liners in the big ends. Five steel-backed lead-indium bearings are used to carry the crankshaft.

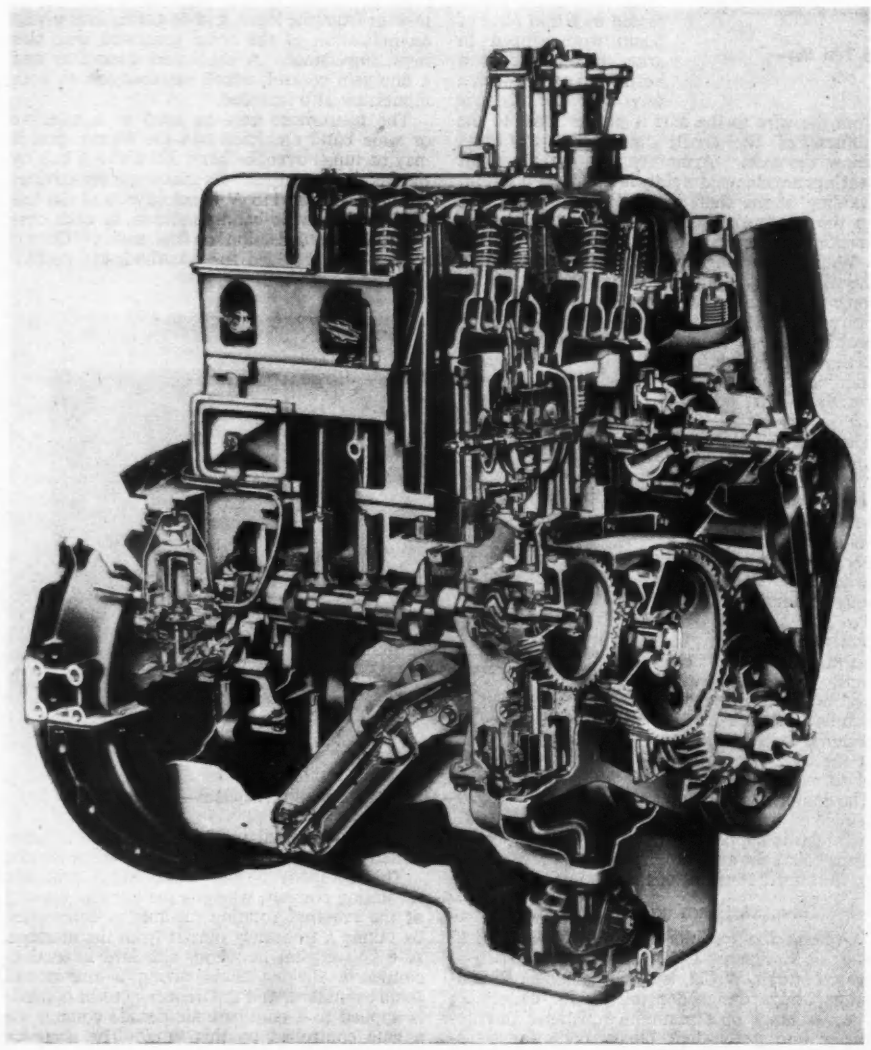
A thermostat is fitted in the cooling system to obtain rapid warming of the engine, and when the correct operational temperature is reached a water impeller ensures free circulation. The inlet manifold is made of cast aluminium so that full atomisation of the mixture is obtained quickly, and the tendency for petrol to wash the cylinder bores is reduced.

All the oil fed to the various bearings passes through the externally placed oil filter so that only clean oil is circulated. An oil trap is incorporated to maintain the pump full of oil under all conditions.

For crankcase ventilation air is taken through an oil bath air cleaning breather on the valve rocker cover, passes through the crankcase and is then drawn out by the vacuum in the main air inlet system.



Combustion Chamber and Valve Gear



70 B.H.P. Four-Cylinder Petrol Engine

Short Notice

The Science of Petroleum, Volume VI, Part I, The World's Oilfields, The Eastern Hemisphere. Edited by V. C. Illing. London: Geoffrey Cumberlege, Oxford University Press, Amen House, Warwick Square, E.C.4. Price 52s. 6d.—This volume represents part of the revision of Volume I and deals specifically with the occurrence of petroleum in the Eastern Hemisphere. Up-to-date information of the more important areas has been contributed by some thirty geologists, having personal knowledge of particular areas, and the policy of presenting critical reviews rather than exhaustive accounts adopted in earlier volumes has been continued. The subject matter is grouped into four sections, which relate to Europe, the Middle East, the Far East and Australasia and Africa. In the European section the U.S.S.R. is omitted, but articles upon certain other countries behind the iron curtain are included because, although not up to date, they present the basic features of the petroleum geology of those countries. In each section there is a general review of the area in question followed by more detailed descriptions of individual countries, and the various accounts cover subjects such as the factors determining the distribution of oilfields, oil source and reservoir rocks, the main producing structures and structural history. The tectonics and stratigraphy of the various regions are discussed and much statistical data included, while numerous maps give geological information, indicate positions of oilfields and many oil belts are illustrated by geological cross sections. There are stratigraphical tables for a number of Middle East countries and also tabular statements giving general data of the various oilfields, including notes upon exploration, exploitation and production. The book provides an authoritative survey of material which usually has to be collected from many sources.

The Electrical Research Association

The following outline of the activities of the Electrical Research Association in 1952 consists of abstracts from the Association's thirty-second annual report, preceded by a résumé of two of the speeches at the recent E.R.A. luncheon.

THE annual luncheon of the Electrical Research Association was held at the Connaught Rooms on Friday, April 10th, under the chairmanship of the president of the Association, Sir John Hacking. The toast of "The E.R.A." was proposed by Sir David Brunt, secretary of the Royal Society. Sir David said that his association with the electricity supply industry began in 1931 when the Electricity Commissioners set up a committee to examine the problems of emission from power station chimneys. The recommendation made by this committee resulted in the adoption of the working rule that the height of the chimney should be two and a half times the height of the power station. Sir David went on to say that he was particularly interested in the work done by the E.R.A. on the use of wind for generating electricity. As a meteorologist he was very impressed by the thoroughness of the wind surveys carried out by the Association and by the design of the electrical anemometer that was specially developed for this work. He said that this anemometer was the most significant development of its kind in the past sixty years.

In his response to the toast, Sir John Hacking touched upon certain aspects of the E.R.A.'s finances. He said that the 20 per cent increase in contributions from members, suggested by the chairman of the E.R.A. Council to earn the maximum grant from the D.S.I.R., had been achieved. As a result, the Association's annual income had increased to £270,000, which was an increase of 50 per cent compared with 1947. But this increase had been largely offset by the decline in the value of money. The strength of the staff had remained constant at about 300 in the six years since 1947. Sir John said that although the money spent on research was a crude yardstick it offered the only practical way of assessing the total research effort. He pointed out that of the total revenue of the E.R.A., one-third came from the electricity supply industry, something less than one-third from the D.S.I.R., and slightly less than one-quarter from the manufacturing industry. He was fully mindful of the direct research effort of the big manufacturers, but their contribution to the E.R.A. was no more than 1 per cent of their expenditure on direct research, and he wondered whether the former figure could not be increased without hardship. Turning to the progress on the Leatherhead laboratories scheme, Sir John said that funds were now available and that all the necessary licences and steelwork allocations had been procured.

Of specific research programmes, Sir John mentioned the long-term research work on fuel cells and high-voltage d.c. transmission. He said that the next step in high-voltage d.c. involved considerable capital expenditure. He thought that there would be little scope for high-voltage d.c. transmission in Great Britain as long as overhead line transmission was practicable, but the position might be very different in any situation where it was essential to use cables.

E.R.A. Annual Report

The thirty-second annual report covering the activities of the E.R.A. from October 1, 1951, to December 31, 1952, was presented at the annual meeting of the Association on April 10, 1953. Some phases of the research effort are briefly summarised in the following abstracts from the introduction to the report.

This year is the twenty-fifth anniversary of the gas-blast and the twenty-first anniversary of the baffle side-blast switchgear inventions of of Dr. Whitney and Mr. Wedmore. The vital arc-control element in most modern high-power switchgear throughout the world embodies in whole or some essential part their ideas and inventions.

Work on the air-break, arc-chute type a.c. circuit breaker has led to a new design of chute for higher powers and voltages. There has been progress in multiple break switches for high voltages. The performance of a.c. fuses on small overcurrents has been studied. Contactor studies have been made up to 1200A, three-phase at 440V.

Interest in cable short-circuit ratings now lies in the behaviour of joints and methods have been developed for the quantitative assessment of this limitation. Ratings for the cyclic loading of cables laid direct have been computed and new facts have emerged on the continuous and cyclic ratings of cables in ducts.

The main investigation of mechanical forces in tapped transformer windings is complete. Other studies include temperature distribution, losses in modern designs, the origin of transformer noise and the design of capacitor bushings. A new magneto-optical method of measuring currents in v.h.v. systems has been shown to be theoretically sound.

Studies with the E.R.A. model d.c. transmission link simulating h.v. operation are virtually complete and a series of patents has been taken out. On the full-scale trial scheme a specific proposal has emerged relating to the cross-Channel power link and is being considered.

The performance of the E.R.A. network analyser has come up to expectations and the additional sections of network elements are being added as components are delivered. The analyser has already proved its value in a number of researches, particularly that on the restriking voltage transients on the B.E.A. 132kV system.

Data on lightning continues to accumulate with the aid of the B.E.A. and Area Boards and voluntary observers. A method for predetermining the behaviour of overhead lines has been developed. There is more satisfactory experience with E.R.A. surge recorders and the surge filter.

Generation.—In generation the most important problem is to raise the working pressures and temperatures of steam turbines. Professor Newitt has made considerable progress with equipment for measuring the properties of steam up to 6000 lb per square inch and 1400 deg. Fah., and hopes the apparatus will be ready this year. Work continues at the N.P.L. on molybdenum steels and also on steels suitable for components operating at 1100 deg. Fah., including Ni/Cr/Nb, Cr/Mo, Mo/V and Cr/Mo/V types of steel. The Chemical Research Laboratory has in hand the study of corrosion at high temperatures. Steelmakers (mainly through B.I.S.R.A.), tubemakers and boilermakers support this work as well as the electrical industry. The B.N.F.M.R.A. continues to study corrosion of condenser tubes.

The survey of potential wind power in the British Isles has been extended to the Shetlands, Isle of Man, East Coast of England and further sites in Scotland and Ireland, making a total of more than seventy sites, most of which are suitable for generators. The Orkney generator has been operated, but is not yet in full commission. Arrangements are in hand with the College of Aeronautics for the testing of prototypes, including those which emerge from the design and costing study now completed.

Agriculture.—The success attending the Association's recommendations on grass and grain drying has encouraged the extension of research on drying to multi-purpose farm drying, moisture equilibria and measurement and seed drying. Electric weed killing and singling seems rather promising, as is also true of electric operation of static and mobile agricultural machinery. Very encouraging results have been obtained from the flash illumination of laying poultry. There is interest in applying the heat pump principle to combined milk cooling and water heating.

Mixed soil and space heating in glasshouses gives substantial savings. Work is also in hand on the illumination of seedlings, soil warming in the open ground, and on soil sterilising *in situ* by earth electrodes, which has reached the prototype stage. The destruction of pests by pulse-modulated radio-frequency fields seems not impracticable. Some experiments on electric fishing continue with the help of the Ministry of Agriculture and Fisheries and the Scottish Home Department.

The growing interest in floor heating has made possible the study of practical installations and a realistic assessment of its advantages. The direct comparison between the heat pump and gas boiler at Shinfield gave satisfactory results and will be repeated. The pick-up of heat from various soils has been determined and consideration given to regeneration of heat from waste hot water and from domestic cooling equipment. Some promising methods of inhibiting scale formation on immersion heaters have emerged. Work is being extended on airing and drying. Some success has been achieved on a laboratory scale on methods of thermal storage to provide a constant temperature heat store with portability where needed.

Unclassified Researches.—Some progress has been made in increasing the life of surface discharge spark plugs on the fine transfer of noble metal contacts, as met in ignition circuits and on ignition capacitors working at high ambient temperatures.

Study of the argonarc welding process has been extended to the self-adjusting and controlled arc welding processes. The E.R.A. surge injector invention is being applied in industry and its extension to ferrous arcs is under consideration.

Magnetic Materials.—Electrical sheet steel of low loss remains an important need of the electrical industry. The B.I.S.R.A. laboratories are undertaking some fundamental work on its production and properties. Iron loss at high flux densities is being studied at University College, London.

The microbeam technique has been developed and is being applied at the Cavendish Laboratory to the texture of metals ; the study of permanent magnet alloys of Fe, Mu, Al, Ni, Co and Cr is also in hand there. At Sheffield University work continues on precipitation in magnetic alloys. Nottingham University has reported on Bitter powder patterns on a single crystal of Ni and has indicated a possible explanation of the association of high permeability with low remanence. The Permanent Magnet Association has studied anisotropy produced in alloys of the Alcomax type. Long-term tests of the stability of permanent magnet samples have begun at the N.P.L.

Components.—In connection with components some new work has started on failures in small resistors and some consideration been given to noise in resistors. The main effort has, nevertheless, been devoted to capacitors, as previously. The industry has taken over the production of stabilised capacitors for light-current circuits and attention is being turned to capacitors for power purposes, e.g. power factor correction, to certain problems with mica capacitors and to the special case of polystyrene capacitors where a curious hazard was discovered from human grease such as from dandruff particles. A new development in electrolytic capacitors shows promise.

Insulation.—Work on non-metallic materials falls into two groups, those investigations of immediate application in industry and those of a long-term nature. In the former group come a number of recommendations for the revision of British Standards on varnish fabric tapes, varnishes, S.R.B.P. sheet, covered winding wires, the electrical and sludging properties of insulating oils, and on tracking over insulating surfaces. At the same time, a good deal of work has been done on new products such as glass, silicone impregnants, new high temperature synthetics containing chlorine and fluorine, the extended use of acetylated paper and the use of inhibitors in insulating oils. Recommendations have been forwarded to the I.E.C. on the revision of spark gap voltage calibrations. The supply position of some materials gives concern and a careful inquiry into the situation over selenium has led to recommendations now being discussed with members and the Government.

Long-term work on the stable properties of dielectrics includes first the accumulation by the N.P.L. of data, over the working range of temperature and the widest possible range of frequency from power frequencies to centimetric

waves, on typical insulants, recently including the silicones and halogenated hydrocarbons and the effect of moisture. The wide use of long-chain molecules in new insulants has led to attempts, with some success, to explain their behaviour on the basis of solid state theory at Liverpool and a more thermodynamic approach at Perivale. The sensitive microbalance previously developed has opened up a new field in the effects of very minute amounts of moisture.

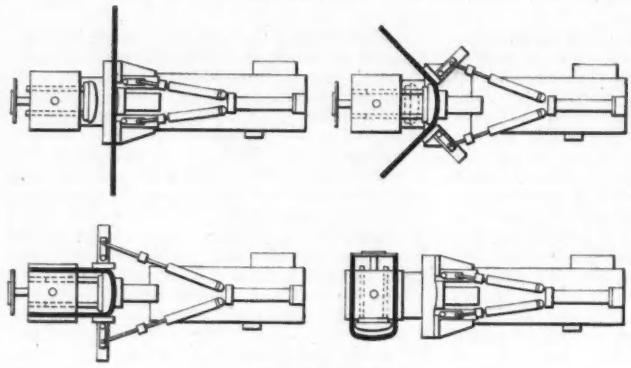
The theory of electrons in dielectrics has been further elaborated and certain questions on the electric strength of crystals have been settled. The main experimental work is directed towards elucidating the mechanism of breakdown by discharges. Further mechanisms of the propagation of partial breakdowns have been exhibited and observations made on the effect of transients, pulses and superposed harmonics. The N.P.L. has extended its data on the impulse strength of insulation. The industrial importance of liquids under pressure has led to a research on the effect of pressure on the electric strength of liquid insulants.

Discharges in polyatomic gases of high electric strength have been studied at Liverpool and also the impulse breakdown of gaps with very slight overvoltages. At Durham the subject is breakdown with centimetric waves, of importance in radar applications. The fields in the cathode space of low-pressure discharges have been determined at Oxford by an exploratory lateral electron beam. The work at Oxford has now been expanded to cover the cathode mechanism of discharges, particularly certain types of arc, where the plasma is independently produced. Recent inventions make use of this principle and important industrial repercussions will be kept in sight at Perivale as well as Oxford. The "glow-arc" transition, which is of such importance in the switchgear arc and lightning, and which was first exhibited at Perivale, has been further studied there, including certain possible applications in cosmical phenomena.

A Sheet Metal Bending Machine

We have received particulars of an interesting hydraulically operated tangent bending machine which has been built by Turner Brothers (Birmingham), Ltd., Cleveland Street, Birmingham, 19, for making double bends in preformed flanged sheet metal components 19in wide up to 156in long, and with 3in corner radii at 18in centres. On this machine both bends are produced simultaneously and, although it is essentially a special-purpose unit so far as the distance between centres of the radii is concerned, it can be used for different lengths of sheet metal components. Means are provided for a small range of adjustment of the centre distances, but this is not specifically intended to provide for different components. With the machine the flanged edge of a panel can be bent to radius form within certain limits without need for cutting the flange section away at the point of rising. A hydraulic compensating device fitted is useful when handling components having a double bend in the flange; it gives a controlled pressure and prevents puckering.

The new machine can be seen in the photograph we reproduce and its method of operation is clearly shown in the accompanying diagrams. On one end of the machine base there is a rotatable turret on which the punch of the required shape is carried on four heavy guide bars. Two hydraulic cylinders in the turret apply the holding pressure on the work, whilst the sheet being bent to shape is wrapped round the punch. On the upright member of the machine body there is mounted the vertical die plate. A substantial steel wing is pivoted on two short spindles on each side of the upright and mounted on these spindles are fixed gear wheels. Alongside each edge of the die plate and adjacent to the spindles is a vertical roller, and fitted between each wing and the vertical roller is a forming plate. Each forming plate has at its top and bottom a short section of rack which engages the corresponding gear wheel. The two wings are linked by means of adjustable connecting-rods to the crosshead, which slides on machined guideways on the base. This crosshead is moved by the piston of a hydraulic cylinder with a stroke of 6in, which is mounted on the base of the machine behind the die plate.



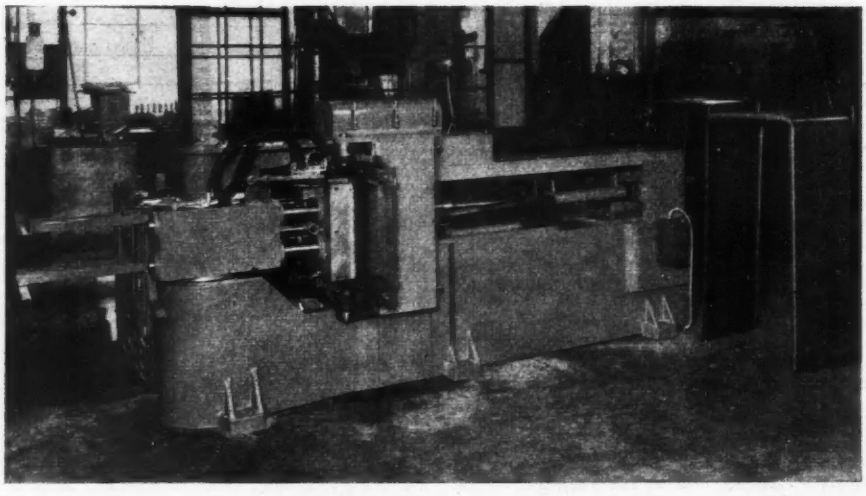
Sheet Bending Cycle

The cycle of operations can be seen in the diagrams. The sheet to be formed is placed between the punch and the die, and the turret cylinders are then brought into effect to apply the holding pressure. As pressure is applied to the main hydraulic piston it swings the wings through an angle of 90 deg. about their pivots until they are approximately at right angles to the axis of the machine. During this movement each of the intermediate die plate members also turns through a corresponding angle, with a simultaneous rolling motion as the racks ride round the gear wheels, and finish in a position parallel to the axis of the machine. As the intermediate forming plates move tangentially in relation to the punch they force the sheet round the punch to form the bend.

On the wings and the punch then being withdrawn the turret is turned by hydraulic power to the unloading position, where the formed sheet can easily be withdrawn.

Within the punch unit there is a small hydraulic cylinder and link system, which operates movable inserts in the punch automatically to compensate for any commercial variation in thickness of the sheet, which might affect the form of the corner radius. The setting of the rollers can be adjusted by means of the screws projecting from the wings.

The Keelavite hydraulic gear fitted on the machine is accessibly mounted for maintenance purposes outside the frame at the rear, and is driven by a 4 h.p. motor. The punch holding force is 14,255 lb at 1200 lb per square inch oil line pressure, the maximum line pressure being 1600 lb per square inch.



Tangent Sheet Metal Bending Machine

Electric Power Generation by a Nuclear Reactor

The U.S. Atomic Energy Commission has announced that the production of useful amounts of electric power by nuclear energy has been achieved due to the successful operation of an experimental homogeneous reactor at the Oak Ridge National Laboratory. On February 24th, a pilot model of the reactor system was brought up to its full designed power of 1000kW of heat output. The steam obtained from the reactor was then fed to a turbo-generator and about 150kW of electricity was produced.

Capable of producing both fissionable material and electric power, the small homogeneous reactor was developed at the Oak Ridge National Laboratory, but it was not designed to produce electric power on an economical basis. It may be recalled that the first demonstration in the United States of electric power production by a nuclear reactor occurred in December, 1951, at the National Reactor Testing Station in Idaho with the operation of the so-called experimental breeder reactor. In the homogeneous reactor, a single homogeneous solution serves as fuel, moderator and coolant. The heat generated by the nuclear reaction of the uranium fuel in the solution is removed by pumping the hot radioactive liquid through a heat exchanger which produces steam to drive a turbo-generator. A homogeneous reactor was built in 1944 at the Los Alamos Scientific Laboratory in New Mexico, and another one is now nearing completion at the North Carolina State College. However, these units are low-power research reactors. The one at Oak Ridge is believed to be the first to operate at a temperature and power high enough for the production of sufficient steam to run a standard industrial turbo-generator. The construction of this reactor at Oak Ridge commenced in March, 1951, following two years of development and design. The reactor "went critical," or achieved its initial nuclear chain reaction, on April 15, 1952. After early low-power operation, the experimental work will now continue at higher powers to obtain information regarding the feasibility of this design for full-scale reactors.

Patrol Boat "Gay Bombardier."—Her Majesty's fast patrol boat, "Gay Bombardier," the first of the class, has completed her acceptance trials. The boat, which has a length of 75ft and a beam of 20ft, was built by Vosper, Ltd., of Portsmouth, and the company has acted as a parent firm for this class of patrol boat, which can be armed either as a gun-boat or a torpedo-boat. As a gun-boat the armament will consist of a 4·5in gun and one of smaller calibre, and in the role of torpedo-boat the armament mounted will be two 21in torpedo tubes and one small gun.

A Novel Hammer Foundation

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

THE author was recently able to inspect a scale model of a foundation for an 8-ton forging hammer at the invitation of Mr. J. H. A. Crockett, B.Sc. (Eng.), A.M.I.C.E., who has designed the installation on behalf of the owners, the International Nickel Company, Huntington, U.S.A.

The hammer is employed for the hot forging of nickel alloy ingots and sometimes for the hot-cold working of nickel and nickel-copper blooms and billets, using superheated steam at high pressure and thus producing almost the maximum shock possible in forging practice. This is the first hammer to be fully analysed for shock, vibrations, movements and loads in all directions ; the first to be provided with inertia blocks of stressed concrete, and the first to use grouted concrete of exceptionally high strength. The latter requirement and the need for maximum possible homogeneity under extremely difficult placing conditions—the reinforcement being very closely spaced in some parts—were met and fulfilled by using specially designed grouted concrete of high strength, which has for many years been successfully employed in the U.S.A. for the renovation of dams, underwater work, and other structures.

The owner specified that the previous large ground vibrations must be eliminated, and that the high maintenance cost of the former installation should, if possible, be reduced. During the last war it was not unusual in this country to find that the maintenance time for a large forging hammer and its foundation when working on light alloys might amount to 85 per cent of the available working hours, due mainly to the fact that until the classic researches of Andrews and Crockett had been undertaken, the behaviour of such machines was not by any means understood.

This 8-ton hammer imparts to the ground an exceptionally heavy shock, blows occurring every three-quarters of a second, so that all oscillations of anvil and foundation, together with those of the superstructure of the hammer, must be completed and the entire system brought to rest within this very limited period. Moreover, amplitude of movement had to be small in order to avoid discomfort to the operating crew and subsequent decrease of production. These were the main factors controlling the sizes of masses employed, the various constants of the springs used and their positions, and the amount of damping with the positions of the Korfund friction dampers in relation to the several masses.

The sketch (Fig. 1) shows the general arrangement of the hammer with its upper and lower inertia blocks, the superstructure resting on the upper block of annular form surrounding, yet free of, the anvil. This block and the anvil are mounted on independent André rubber springs, which sit on the lower concrete block : the latter is mounted on helical springs located near the bottom of the pit, whereby live load to the soil has been reduced to only a few tons. A sump has been provided at the bottom of the pit to catch condensate water, cooling water and any ground seepage which may occur. The important feature of the design is that the anvil and the upper block with superstructure are in exact oscillatory relationship to one another through the medium of the lower block.

Every part of the installation is completely visible and accessible for maintenance, this being regarded as a feature of paramount importance by the designers ; if any part should fail it can be removed and replaced without disturbing the other parts. In conventional foundations it has nearly always been necessary to dismantle the hammer, cut away the concrete surrounding the anvil, and the anvil must be jacked out of the foundation before any repairs can be made, a long and costly operation, during which production ceases for months.

The shock wave which travels through an anvil and the rest of the system of a hammer foundation has a wave-length determined by several factors, namely, duration of the blow ; the density of the material through which the shock wave travels, and the Young's Modulus of the material. This wave-length is only a few feet in the case of this particular hammer, and this very short wave length creates special problems. This wave has been compared to a very high-power sound wave, being reflected and refracted from surfaces and boundaries in exactly the same way. The shock wave reaching the bottom of the anvil is partly reflected back again, but a small proportion is refracted through into the rubber spring, then from the rubber through its boundary into the concrete.

At this point very special care must be taken, because concrete normally has very small tensile strength ; shock waves in compression, when reflected from a concrete-air boundary, are reflected in tension, and should any of these come to a focus at any point the tension may build up to such an extent as to cause failure. Concrete blocks must therefore be given an enveloping shape which will cause the stress waves inside them to disperse rather than to come to any focus.

Velocity of travel of a stress wave in any material is proportional to the square root of Young's Modulus times gravity divided by density and therefore any wave approaching a plum of good concrete surrounded by concrete of inferior quality will increase its velocity in passing through the plum, while the wave in the adjacent poorer concrete will remain at the same velocity. Thus, there will be a difference of phase between the two parts of the wave, which will set up a strong shearing action around the envelope of the plum, culminating in the possible breakdown of the concrete. Indeed, this may be the explanation why many old hammer foundations made of very poor concrete have remained unbroken for many years, since they may be of consistently poor concrete throughout. From this it follows that concrete in a hammer foundation should be of the most uniform consistency attainable in practice.

Concrete may fail in fatigue in the same way as steel. Failure will occur in concrete when

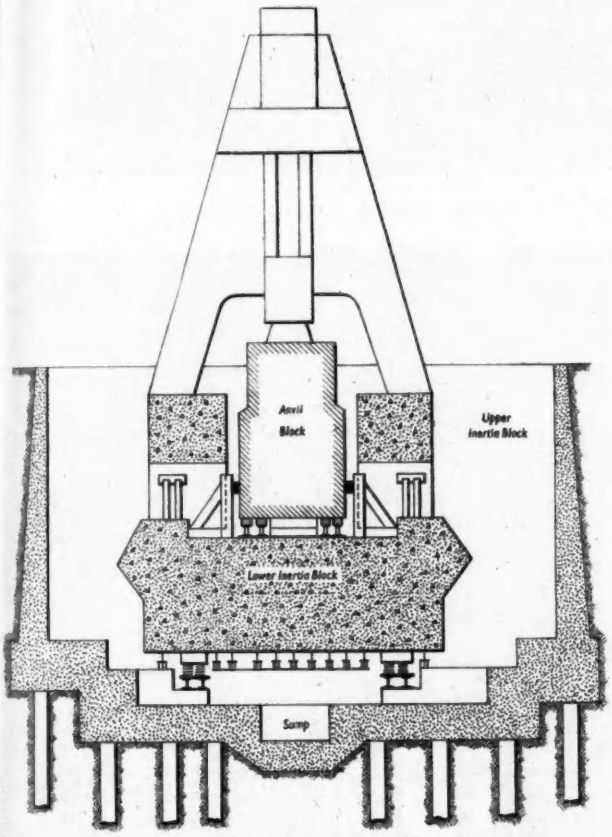


Fig. 1—Arrangement of Vibration Controlled Foundation for Forging Hammer

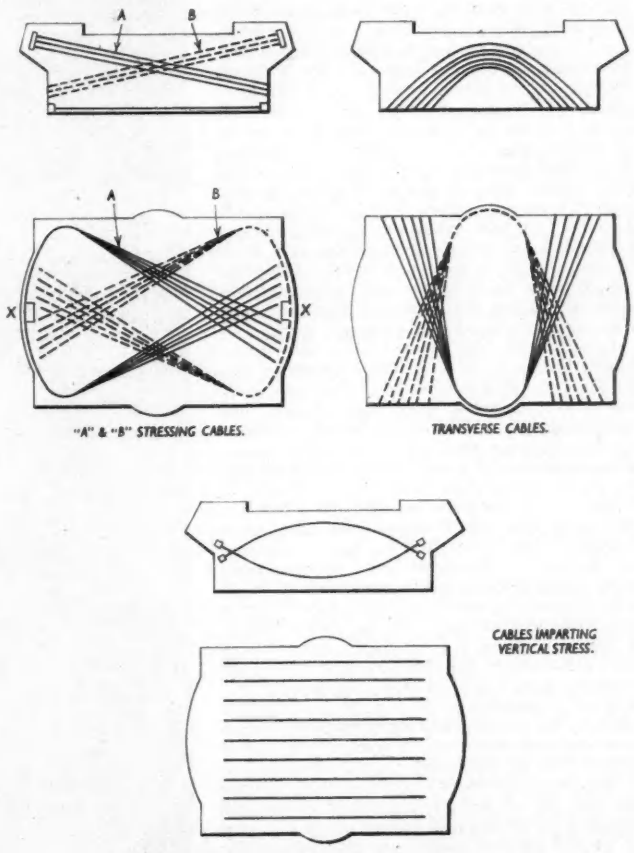


Fig. 2—Arrangement of Stressing Cables

the water-cement ratio is high rather than when it is low, and it is also good practice to allow the concrete to harden for as long as possible before use ; after a few hundred thousand reversals of stress, strength of concrete may be reduced to only half its original value. This condition applies particularly when stress is oscillated from tension to compression and back again, but this will not be so marked if the stress is kept entirely compressive, so that changes are either a little more or a little less compression. This result can be achieved only with modern stressed concrete. In this particular case, even under fully controlled conditions, live load from the anvil is about five times the dead load, so that the problem is very pronounced.

Upper and lower inertia blocks each weigh about 160 tons, the former being mounted on four massive legs so that access can be provided to the side-controlling springs and dampers, and to the sides of the anvil and its springs. A good example of the benefit of this arrangement occurred shortly after the hammer started work, when certain adjustments were necessary.

There was no reliable information as to the temperature which the lower parts of the anvil were likely to reach, but there had been reports that old timber pads under certain anvils had been charred when taken out, the topmost portion of the anvil becoming red-hot after prolonged forging. In this case it was most important that the rubber springs must not be allowed to get too hot in order to ensure that they would have a long life, and after starting the hammer daily records of temperature were kept ; when this temperature had reached 120 deg. Fah., a very small water spray was put into action, which at once lowered the anvil temperature to a reasonable level. In winter this may not be necessary, but in summer it is essential ; however, the great majority of hammers would not need such cooling.

Concrete for the upper and lower inertia blocks had to be of a quality higher than that of conventional concrete, even when employed for stressed concrete work and having a low water-cement ratio, but the most important requirement was that it should be as homogeneous as it was practicable to make it with no construction joints, and that it should be stressed in compression in all three directions. It was specified that it should have an ultimate breaking strength of 10,000 lb per square inch on the basis of a 6in test cube. Fig. 3 shows a scale model of the extremely complex and closely spaced reinforcement in the lower block. Reinforcement in place can be seen in Fig. 4, a reproduction of a photograph taken during the construction of the block. The main stressing cables are of the Freyssinet type, enclosed in standard sheathing of 1¼in diameter, so that the cables could be stressed after the concrete had hardened. There is one set of cables running diagonally (Fig. 2) from top to bottom along the major axis of the block, another set running in the same manner across the width of the block, and a third set in the form of parallel pairs of cables also along the major axis of the block.

Much research was carried out to find the best possible aggregate and particularly grout for the Prepakt concrete, and it was decided to use a crushed limestone from Fort Springs, West Virginia, about 250 miles from the Inco works. After many tests in the University of California, it was decided to employ a 9 : 1 : 6 mixture for the concrete, this representing nine parts of cement, one part of Alfesil, and six parts of sand ; Alfesil is a very fine dust or fly ash derived from electrostatic precipitation in the boiler flues of large power stations. Normal Portland cement was used to keep down heat, an air-entraining agent being added to increase easy flow of the grout, while the setting off was controlled to begin fifteen hours after mixing by the addition of another substance. Compression tests on 6in by 12in cylinders on site have since given breaking strengths of 4010 lb per square inch at six days, 7020 lb per square inch at sixty days, and 10,600 lb per square inch at 180 days ; further tests will be carried out at one year. The large increase in strength from twenty-eight days to the later periods are produced by the pozzolanic qualities

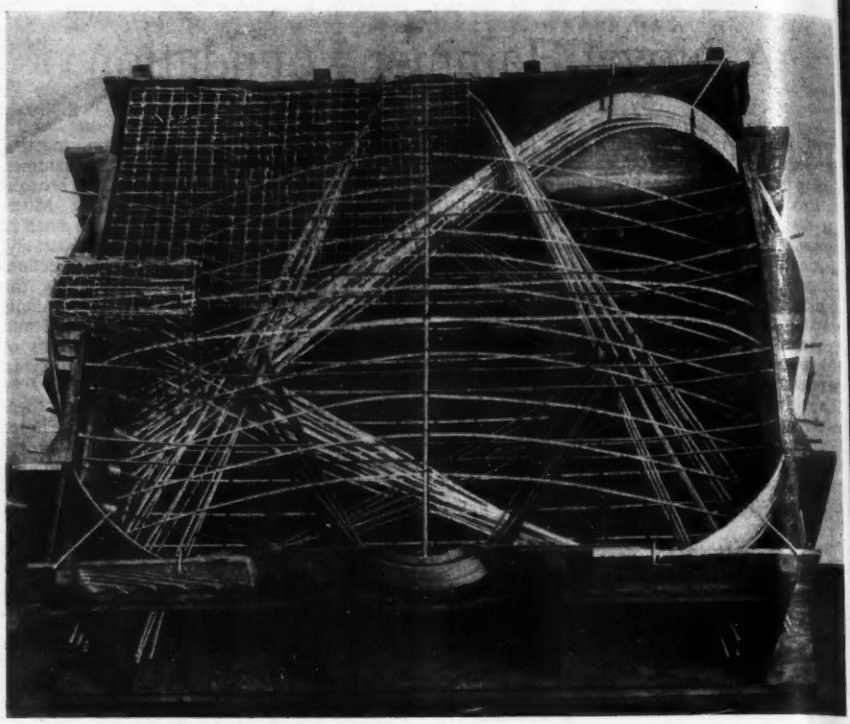


Fig. 3—Scale Model of Lower Inertia Block Formwork

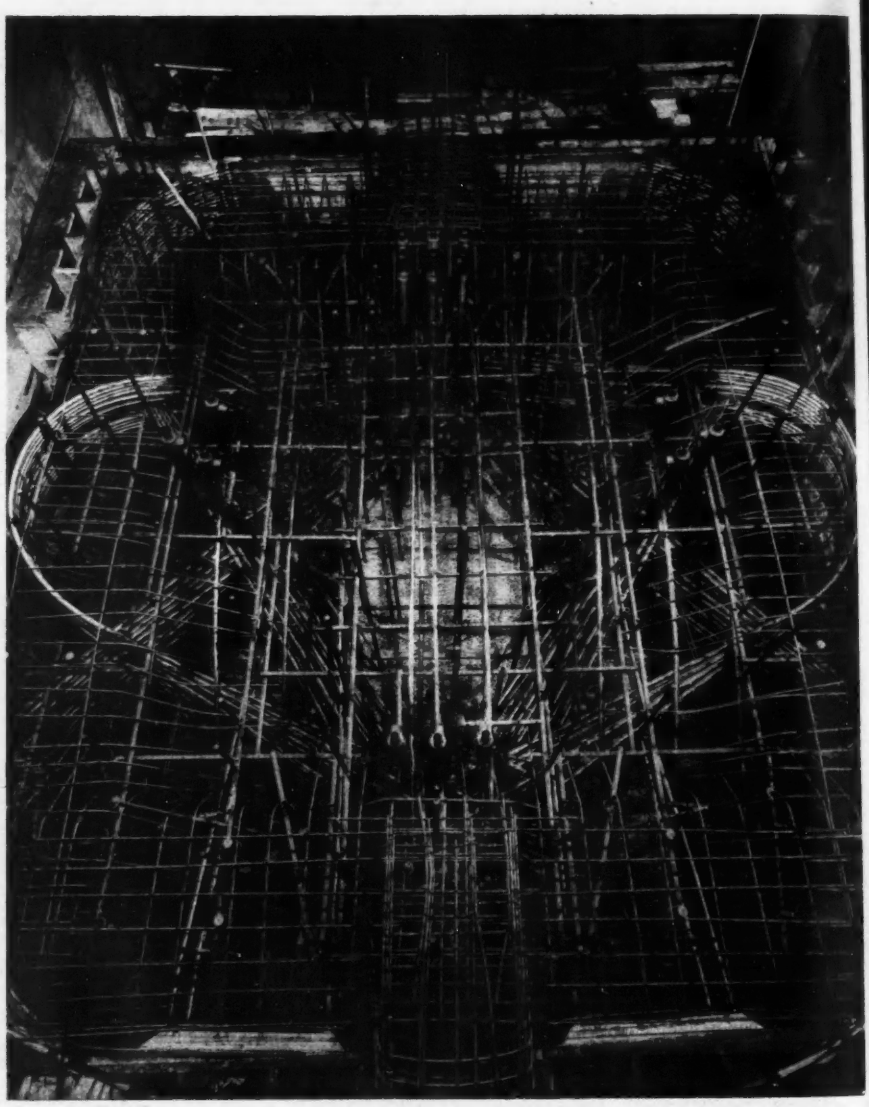


Fig. 4—Stressing Cables and Reinforcement in Place in Shuttering for Lower Inertia Block

of the fly ash. The equivalent 6in test cube strength at 180 days gives the exceptionally high result of 13,000 lb per square inch and it appears that a value of 15,000 lb per square inch may be attained.

The Freyssinet stressing cables were fabricated in accordance with instructions given by the Freyssinet Company, each cable being made up of twelve wires 0·20in diameter, evenly spaced around a central wire spring and encased within the thin metal sheath. These wires have a carbon content of 0·7 per cent, a yield stress of about 150,000 lb per square inch, and a tensile strength of about 210,000 lb per square inch.

After all reinforcement had been placed and the cables and holding-down bolts had been correctly located, the aggregate was filled into place. On the afternoon before grouting the lower inertia block, about 5½ tons of ice were spread over the top surface of the aggregate and sprinkled with water; this chilled water seeped down through the aggregate and reduced its temperature to about 50 deg. Fah. by the next morning. Grouting of the aggregate was started at about 8 a.m. and was continued satisfactorily until about 4 p.m., by which time the grout was within a few inches of the top of the block. At this point the grouting pressure had to be increased, which resulted in some mechanical trouble with the pumping equipment, owing to the abnormally high pumping pressure which had to be employed. Pumping of the grout was continued with a stand-by single-stage pump, and grouting was not completed until 1 a.m. the next morning. Under normal conditions grouting would probably have taken about ten hours. However, it did not adversely affect the concrete owing to the retarding agent which had been added.

Stressing of the cables was started nine days after completion of grouting, when the concrete had attained a strength greater than 4000 lb per square inch. The specification for prestressing laid down that the load should be 140,000 lb per square inch and this stress has actually been put into all the cables, although stress measurements could not be made on some of them owing to the curvature to which they were bent. This applied particularly to the looped cables running diagonally along the major axis of the block. Theoretical coefficients of friction around the curvature of these cables was calculated to be 0·21 and using this value there is every indication that the cables had been properly stressed. However, coefficients of friction of 0·3 and higher have been found for curved cables of this kind.

For these reasons it was decided to use concrete of very high strength with low water-cement ratio, stressing the concrete in all three dimensions simultaneously although this technique had never before been employed. All sideways-acting rubber springs are mounted on the lower block on brackets of welded steel, and to prevent them from lifting and rattling these brackets are held down tightly to the lower inertia block by high-tensile Lee-McCall stressing bars, recently developed for stressed concrete. These bars, used as holding-down bolts, were jacked at their lower ends under the block to a stress of 30 tons per square inch. When the brackets were suitably shimmed, their diagonal member induced into the side springs a pre-compression such that under no conditions of oscillatory movement at anvil or upper block will they ever become loose or chatter, even though a heavy eccentric blow of the hammer may cause considerable lateral and rotational movement of all masses. The greatest eccentric blow on the anvil occurs when a 2-ton weight, lifted by the overhead travelling crane, is swinging 40ft on to the top side of the anvil for driving in the keys, or fixing wedges, used for holding the anvil pallet tightly in place. The André rubber springs on which the anvil block rests are the largest that have so far been made; similar ones are used under the upper inertia block.

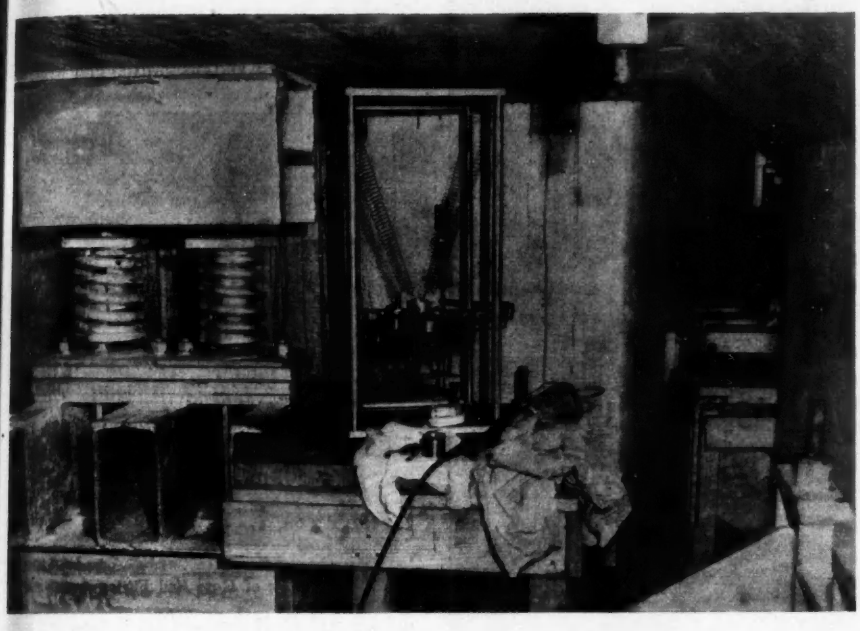


Fig. 5—Helical Springs and Vibrograph Under Lower Inertia Block

The superstructure of the hammer and the anvil are thus located horizontally in relation to one another with high precision, and with practically no chance of them becoming out of true once they have been adjusted and the rubber has taken up its initial and working creep. Since 1843 hammer makers have been trying to solve this very difficult problem of accurate relative location and at last the solution has been attained, in this case through complete vibrational control. In other words, the machine, the foundation and the ground are all completely inter-related.

Before the hammer was placed in service vibrographic readings were taken of all main movements of anvil, and of the upper and lower inertia blocks, in order to check frequencies and amplitudes under different working conditions. About sixty sheets of vibration and force calculations were made, and the check showed an accuracy of 5 per cent, which is remarkable; the structural calculations which followed covered about forty sheets. The vibrograph was a special instrument designed to withstand an acceleration of 2000g (Fig. 5). The various frequencies of all masses are quite distinct from the natural frequency of the ground, previously measured at 8·5 c/s, so as to prevent any resonance.

The installation was completed in October, 1951, and the hammer was placed in operation on the 29th of that month, since when it has been regularly working six days a week, and is served by three mechanical manipulators; the author has been told by Mr. Crockett that there is practically negligible ground vibration about 70ft from the hammer. Many inspections of the concrete have been made since that time and the only defects observed have been hair cracks in the secondary concrete covering the cable anchors and the ends of the wires. This is of no structural importance and merely affects the appearance of the finished job. These two blocks are claimed to be among the most satisfactory large concrete blocks yet made, and no honeycombing or other blemish appears on them at any point.

The only unsatisfactory Prepakt concrete was that directly under the base of the anvil. In January 1952, a little more than two months after the hammer began work, it was observed that apparently the rubber springs under the anvil had shifted. Further inspections throughout the early part of February showed that the steel base-plate under the anvil, made up of five separate pieces, was apparently sinking into the concrete. The anvil was lifted and the rubber springs and base-plate were removed to permit of the concrete being examined.

In places the concrete had been depressed to a maximum amount of half-an-inch; the surface of the concrete was hard and firm, and the erosion was not due to any defect of the concrete itself. It is believed that during the grouting operation some of the froth which seems to be inherent in Prepakt concrete was not completely forced out from below the base-plate. This froth is composed of air bubbles in a very thin mixture of cement and water and has almost no structural strength. Satisfactory repair work was carried out without dismantling the installation and there has been no further trouble.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London S.W.1.

ENGINE LUBRICATING OILS (H.D. TYPE)

No. 1905 : 1952. Price 7s. 6d. This publication lays down standards for the quality and performance of additive oils for compression ignition engines. At present there is no test method developed using a British engine which has been sufficiently widely examined under controlled conditions to permit its adoption as a British Standard, and therefore this standard has been based on U.S. Army Ordnance Department Specification MIL-0-2104.

It must not be assumed that the assessment of oils by these engine tests would be valid under other than the test conditions (e.g. with fuels of different sulphur content) or in other engines (e.g. two-stroke engines). Many compression ignition engines do not need this special kind of oil, and others, running under lower loads than the test engines or under variable load conditions, may be satisfactorily lubricated with oils of lower quality; on the other hand, conditions may be more arduous, e.g. because of supercharging or of extra-high sulphur content of the fuel, and oils of higher performance may be required.

Even for engines which do not strictly require heavy-duty oils for their satisfactory lubrication a worthwhile benefit in reducing ring sticking or in extension of overhaul times may be secured, even though quantitative evidence is difficult to obtain.

This specification therefore is intended to safeguard the standard of supplies for those users who are convinced they secure sufficient benefits from this type of oil, and to define the nature of the oils for those who wish to establish their field of usefulness.

An engine test is inevitably complicated and it has not been found possible at present for the results to be completely assessed numerically. A special procedure has therefore been adopted. This is that the engine tests shall be carried out in a laboratory approved by the British Standards Institution, and that the laboratory report and other material shall then be submitted to a special sub-committee of the Mark Committee of the British Standards Institution for the purpose of assessing whether the oil complies with the requirements of this standard. It is intended that the standard of the assessment of this sub-committee shall be as closely as possible the same as that of the American reviewing board, but there is no official connection between the two bodies. The standard also gives details of the physical properties required.

Gas Scrubbing Plant

In our issue of February 27th last it was noted briefly that the Power Gas Corporation, Ltd., of Stockton-on-Tees, had introduced a mobile pilot Pease-Anthony scrubber plant, which was available for experimental purposes on a variety of applications. We have now received from the Corporation some notes on these Pease-Anthony scrubbers, which are widely used in the United States for cleaning gases and are now being used on several applications in this country.

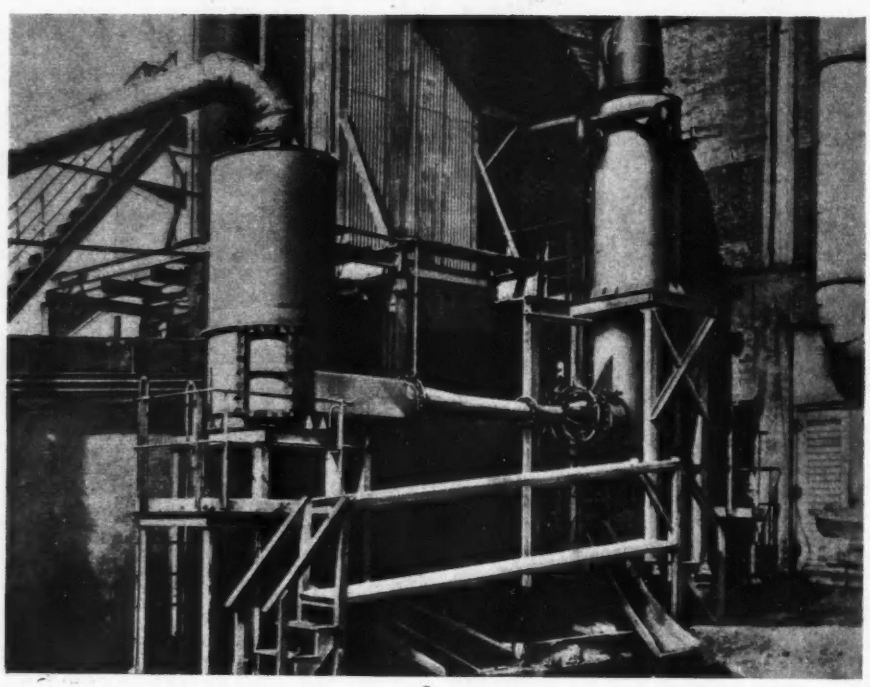
There are two main types of scrubbers, the first to be developed being the " cyclonic " spray, which has now been in use for nearly twenty years. In a normal installation of this design duty gas enters tangentially at the base and spirals up through a fine spray made by suitable nozzles mounted on an axial manifold. The centrifugal force of the rotating gas spins the fine liquid droplets out to the wall of the tower and the dust particles are wetted by collision as they pass through the spray zone. The finest wetted particles and spray droplets are thrown out in the upper section of the scrubber. This scrubber with suitable nozzles, liquid pressures and quantities, is very effective for removing particulate matter down to about 1 micron in size, and it has been used in such applications as lime kilns, boiler plants, superphosphate dens, &c.

For treating finer dust and fumes which are not dealt with completely by the cyclonic scrubber, the Pease-Anthony venturi scrubber was developed. This scrubber is based on the principle of fine atomisation of liquids by high-velocity gas streams. In it the scrubbing liquid is introduced into or just ahead of a venturi throat under low pressure and is distributed to give a fairly complete apparent curtain of water across the throat. The dirty gas, at a velocity usually in the range of 200ft to 300ft per second, collides with the curtain of liquid at the venturi throat, where the liquid is briefly but violently accelerated and disrupted. The fine particulate matter in the gas is wetted by the finely atomised liquid droplets and considerable coalescence of droplets occurs in the diverging section, resulting in drops of liquid large enough to be removed from the gas stream by centrifugal force.

The coalescence is thought to be mainly due to collision and impaction, but diffusion or molecular bombardment, electrostatic charge effects and condensation may all be involved.

The gas is normally drawn through the system by an induced draught fan, usually placed after the cyclonic separator, where it is dealing with a reduced volume of clean gas.

There are three main design variables which have important effects on the results of the venturi scrubber. These are the velocity of gas in the throat, the ratio of liquid to gas, and the distribution of liquid in the throat. The first two of these variables have a considerable effect on the pressure drop across the venturi. Most of the power required for operation of the scrubber is expended on overcoming the resistance in the venturi, since relatively small quantities of liquid are required at low pressure. A correctly designed venturi will recover about 85 per cent of the differential pressure encountered between the inlet and the contracted throat section. However, here a liquid is injected at the throat having zero velocity with respect to the flow of gas. The work done in accelerating and atomising this liquid is reflected in the pressure drop across the venturi. In actual operation it is possible to obtain similar scrubbing efficiencies with a high gas velocity and reduced liquid rates or with a lower gas velocity and higher liquid rates. The fan power required will be higher with the higher liquid rates.



Pilot Gas Scrubbing Plant in Use

Commercial installations are operating with liquid rates in the range of 2 gallons to 10 gallons per 1000 cubic feet and with varying velocities giving pressure drops ranging from 6in to 30in W.G. These installations include steel furnaces, non-ferrous metal furnaces, copperas, roasting phosphoric acid plant, detergent spray driers, &c.

When treating hot gases it is preferable to employ a saturation chamber before the venturi, which serves to cool the gas and also establishes more constant conditions at the venturi in cases where temperature fluctuations occur during a process. Normally the venturi is followed by a dry cyclonic separator, but for some difficult cleaning problems it may be necessary to use a cyclonic scrubber in series with the venturi to obtain a satisfactory effluent.

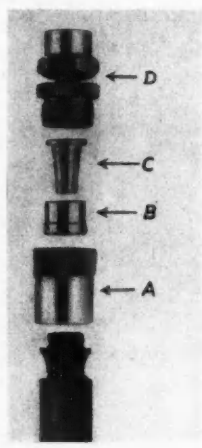
Whilst the venturi and cyclonic scrubbers have been used successfully in many different applications, there are cleaning problems where preliminary experimental work is required to establish the optimum conditions for scrubbing. To deal with such problems the Power-Gas Corporation, Ltd., of Stockton-on-Tees, has made available the pilot plant which is shown in the illustration on this page. The plant which can be dismantled for transport on a road lorry, consists of a venturi scrubber and cyclonic scrubber in series. It is completely self-contained with its own fan and water pump and tests can be carried out using either of the two scrubbers or both in series. With it water quantities and gas velocities can be varied to determine the best possible conditions for scrubbing.

A High-Pressure Hose End Fitting

A new design of high-pressure, high-temperature hose detachable end fitting is now being made by Bowden (Engineers), Ltd., Willesden Junction, London, N.W.10. The flexible hose being used with the new end fittings consists of a lining and outer cover of synthetic material reinforced with one or two braids of high-tensile steel wire and is available with inside diameters from $^{5}/_{32}$in to $\frac{1}{2}$in.

The hoses having a single wire braid reinforcement from $^{5}/_{32}$in to $\frac{3}{8}$in inside diameter are suitable for working pressures of up to 3000 lb per square inch, whilst the $\frac{1}{2}$in and $\frac{5}{8}$in hoses can be used with pressures up to 2000 lb and 1500 lb per square inch respectively. Double wire braided hose of $\frac{1}{4}$in inside diameter can be used for pressures up to 5000 lb per square inch, the $\frac{3}{8}$in., $\frac{1}{2}$in and $\frac{5}{8}$in double braided hoses being suitable for pressures up to 4500 lb, 4000 lb and 3000 lb per square inch respectively.

In the new hose end fitting the reinforcing wires are positively locked to withstand high internal pressures and its swivel end can be quickly and easily removed for inspection purposes, and replaced. The arrangement of the units and assembly of the swivel union end fitting can be seen in the above illustration. The hose end is prepared, as shown, with the cover cut back and the braid drawn a little away from the inner lining. The sleeve nut *A* fits closely over the cover on which it is pushed until an annular ridge in its bore contacts the top of the cover. An interlocking cone *B*, which fits over the outside of the lining, is then inserted into the top of the sleeve nut with the braid between the bore of the sleeve and the outside of the cone. The tapered insert *C* is then pushed into the bore of the hose and its upper flange registers on the top of the cone. Upon the nut of the swivel union *D* then being screwed into the top of the sleeve nut it presses the insert downwards on to the interlocking cone. As the cone is then forced down into the sleeve nut the braid of the hose is gripped between the annular ridge in the nut bore and the lower radiused edge of the cone to lock the assembly rigidly on the hose. The end fitting illustrated has its sleeve nut and union knurled to provide a grip for locking purposes, but fittings are also made with standard hexagons so that spanners can be used in assembling and locking the units together.



Units of Hose End Fitting

Railway Sidings at Harlow.—The Railway Executive states that new rail connections and siding accommodation are to be provided by the Eastern Region to serve the industrial estate which is being established by the Harlow Development Corporation on land west of the present goods yard at Harlow. The total cost of the work, exclusive of land, is expected to be about £45,000.

Industrial and Labour Notes

Employment and Unemployment

The Ministry of Labour has stated that there was a slight reduction in the size of the total working population in Great Britain during February. At the end of that month it numbered 23,276,000 (15,870,000 men and 7,406,000 women), compared with 23,285,000 at the end of January. At the end of February, there were 873,000 men and women serving in H.M. Forces, and there were 22,015,000 (14,771,000 men and 7,244,000 women) in civil employment.

The number of people at work in the basic industries at the end of February was 4,022,000, or 4000 less than at the end of January. The whole of the reduction occurred in the transport and communication industries. Coal mining manpower, at 721,000, showed no change at the end of February compared with the end of January. The total number employed in the manufacturing industries at the end of February was 8,694,000, which was 5000 fewer than a month previously. Additions during February to the labour forces of the textile and chemical trades were offset by reductions in metal manufacture and in the group of industries classified as "engineering, metal goods and precision instruments." In this latter group, the reduction amounted to 9000, the labour force at the end of February totalling 2,549,000. In the non-manufacturing industries, the only manpower increase in February was in the building and contracting trades. They added 14,000 to their labour forces, making their total at the end of the month 1,412,000.

The Ministry's latest report on unemployment relates to March 16th, on which date 397,038 people were registered as out of work, compared with 428,820 on February 16th. The March figure is estimated to represent 1·9 per cent of the total number of employees. It included 39,221 people who were described as "temporarily stopped." The Ministry says also that in the week ended February 28th there were about 112,000 operatives in manufacturing establishments who were reported to be on short time, losing eleven hours each on the average. There were, however, 1,233,000 people working, on an average, seven and a half hours' overtime.

Industrial Progress in Wales

Last week, the Minister of Supply, Mr. Duncan Sandys, spent two days visiting industrial establishments in South Wales. At the end of his visit, the Minister said that the Government fully recognised the important and increasing contribution which Wales was making to the national economy. In the field of rearmament, contracts for many items of military equipment had been placed in Wales, and taking into account also her large contribution in basic materials, such as steel and aluminium, there was no doubt that Wales was playing a full part in Britain's defence effort.

Mr. Sandys went on to say that Wales was to be congratulated on the progress made in recent years in the diversification of her industry. To-day, there was hardly any major product which was not made wholly or in part in the Principality and new industries were continuing to be started. It was most important, Mr. Sandys continued, to encourage that trend above all in the West of South Wales, where a special problem had arisen in connection with the modernisation of the tinplate industry. The different Government departments concerned were co-operating with Lord Lloyd's committee to examine all possible means of attracting new industries, with a view to providing alternative employment for those affected by the closing down of the hand mills. As part of the effort to make the area more attractive to industrial enterprise, special attention was being paid to improving roads and other communications.

The production of tinplate in South Wales, Mr. Sandys added, was now running at nearly 1,000,000 tons a year, which represented virtually the whole of the tinplate output of the United Kingdom. In considering the present difficulties over tinplate, it must be remembered, Mr. Sandys said, that the problem had not arisen through any setback in the industry. On the contrary, it was solely the result of the remarkable technical progress which the industry had made in recent years. Old-fashioned methods were being rapidly replaced by up-to-date plant of which the works at Margam and Trostre were striking examples, and, with the new works at Velindre, Wales would have a fine modern industry which would enable her to hold her own in competition with tinplate producers in any part of the world. That, Mr. Sandys observed, would provide assured employment under excellent conditions for a considerable number of people.

The Price of Heavy Steel

The small adjustment in the controlled prices of British steel—amounting on average to an increase of 12s. 6d. a ton—which was made on March 14th, was designed to cover the direct effect of the latest rise of 10 per cent in coal prices. British steel prices, however, and especially those of heavy steel products, remain low. In the latest issue of its *Monthly Statistical Bulletin*, the British Iron and Steel Federation examines the implications of this relative cheapness, and questions whether British prices for heavy steel are too low in relation to the world level and to the full cost of production.

Figures which are given in the *Bulletin* indicate that American steel prices are up to 30 per cent above British and that, when comparison is made with products of comparable quality in Western Europe, the difference is greater still. Taking the example of plates—for which to-day the pressure of demand is most acute—the *Bulletin* points out that British and American plate prices were fairly close together immediately after the war. American prices began to move away from the British level in 1948 and, following devaluation in 1949 the gap became wider still. Even with adjustments to the higher level of raw material costs, prices of plates in this country are still about £4 15s. a ton lower than the American prices. In Germany, the prices of heavy steel plates, which were almost identical with the British in mid-1948, are now nearly £15 a ton higher than they are here. As well as asserting that British steel prices are low in relation to the world level, the *Bulletin* shows that they are also low in relation to the general level of prices in this country, and especially in comparison with non-ferrous metals and timber. The Board of Trade indices (1938=100) show that iron and steel prices have risen by less than 160 per cent since pre-war, whilst all other articles included in the indices have risen by 240 per cent, and non-ferrous metals by as much as from 410 to 560 per cent.

The *Bulletin* says that the policy of price stability for steel has much to commend it, provided that it is not regarded as a policy to be pursued in boom periods only, and that the controlled price is adequate to cover the true long-term costs of production, making allowance for the changes that take place as additional plant is brought into use. But it is urged that the whole question whether heavy steel prices are properly related to true long-term costs of production is one that merits prompt consideration. Yet whatever the final answer may be, the gap between British and world prices is at present wide enough to enable any required adjustment to be made and still to leave British steel prices among the lowest in the world.

Steel Production

Steel production in Great Britain continued at a record rate during the month of March. Figures published this week by the British Iron and Steel Federation show that the average weekly output of ingots and castings was 351,400 tons, which represented an annual production rate of 18,272,000 tons. The best production in March hitherto recorded was in 1950, when steel output averaged 329,800 tons a week. Pig iron output in March again increased, the average weekly production being 215,700 tons.

In the first quarter of this year, the total production of steel ingots and castings was 4,552,000 tons, the average annual rate over the quarter being 18,207,000 tons. In the first quarter of last year, the total output amounted to 3,998,000 tons, the average annual production rate during that period being 15,991,000 tons. Pig iron output in the first quarter of this year averaged 214,500 tons a week, and was thus at an annual rate of 11,152,000 tons. In the first quarter of last year, at an average of 199,100 tons a week, pig iron production was running at an annual rate of 10,355,000 tons.

Copper Scrap

The Minister of Supply has made an Order abolishing price control on secondary copper and copper scrap. It is stated that these are now in good supply and have been selling below the controlled maximum prices. The Order, which is entitled the Copper, Zinc, &c., Prices (Revocation) Order, took effect on April 9th, and marks the end of statutory control over the prices of non-ferrous metals. It will be recalled that, during last year, progressive improvements in supplies enabled the Government to end price control on a number of secondary non-ferrous metals, including lead, zinc, aluminium, gunmetal, cupro nickel and brass.

Duty-Free Machinery Imports

In our issue of March 27th, we noted the setting up, by the President of the Board of Trade, of an independent committee to review the long-term problems of duty-free entry of machinery into the United Kingdom. This committee, of which Sir Henry Wilson Smith is chairman, held its first meeting on April 2nd.

It has now been announced that the committee will welcome evidence in writing from interested persons or organisations. Letters or memoranda should be addressed to the Joint Secretaries, Board of Trade (Room 3135), Horse Guards Avenue, London, S.W.1, and should be submitted before May 15th. Individuals or organisations intending to submit such evidence are asked to inform the joint secretaries immediately. It is requested that those intending to offer evidence should bear in mind the committee's terms of reference, which are : "To consider and report whether it is in the national interest to provide for the duty-free admission into the United Kingdom of machinery, either by classes or in individual consignments, and, in this connection, to review the provisions of Section 10 of the Finance Act, 1932, and their administration, and to recommend what, if any, changes should be made."

Industry in London and the S.E. Region

At a recent meeting of the London and South Eastern Regional Board for Industry, mention was made of increasing German and Japanese activity in overseas markets. An example was quoted of a firm making cameras, binoculars and optical equipment which had reported growing competition from Japan in those products, especially in the U.S.A., Burma, Malaya, South Africa and Sweden. This firm stated that the Japanese articles were being offered at a price which was about half that quoted by this country.

Attention was also drawn at the meeting to a recent statement by the Chancellor of the Exchequer on coal supplies. This statement was made at a meeting of the National Production Advisory Council, when the Chancellor pointed out that coal consumption had risen fairly rapidly in recent months. Whilst the Government's diagnosis of the coal position was that supplies for industry should be adequate, the Chancellor thought that firms would be well advised to accept all coal now being offered to them.

Notes and Memoranda

Rail and Road

NATIONAL ROAD SAFETY WEEK.—The Minister of Transport has decided, on the advice of the Committee on Road Safety, that a National Road Safety Week should be held from October 17th to October 26th next. It is stated that plans are now being prepared and will be announced shortly.

PERMANENT WAY TOOLS ON BRITISH RAILWAYS.—It is announced that British Railways will investigate the possibility of standardising more than a hundred different kinds of tools, such as shovels, hammers, tampers and spanners, of which more than a quarter of a million are now in use by the permanent way staff. Long usage has caused the design of some tools to become traditional and shovels, for instance, have many different types of handles in various parts of the country. Some designs have already been agreed in principle. These are now being tested out by the 50,000 permanent way staff in the Regions before final decision is taken.

Air and Water

RUNCORN-WIDNES BRIDGE.—Following a recent meeting of the Runcorn-Widnes bridge committee, it was stated that it was hoped to begin the construction of the proposed suspension bridge over the Mersey between Runcorn and Widnes in the autumn.

METEOROLOGICAL OFFICE APPOINTMENT.—The Secretary of State for Air has approved the appointment of Professor O. G. Sutton, F.R.S., at present Dean and Bashforth Professor of Mathematical Physics in the Royal Military College of Science, Shrivenham, to succeed Sir Nelson K. Johnson, D.Sc., as Director of the Meteorological Office on the latter's retirement in the autumn of this year. Dr. Sutton began his career in the Government Scientific Service in the Meteorological Office in 1928, but in recent years much of his time has been spent in armament research. In 1941 he was placed in charge of research in chemical défence, and in 1943 he became Superintendent of Tank Armament Research. Towards the end of the war he was appointed Chief Superintendent of the Radar Research and Development Establishment at Malvern, in succession to Sir John Cockcroft. This post he held until 1947, when he became Bashforth Professor of Mathematical Physics in the Royal Military College of Science at Shrivenham. In 1952 he was made Dean of the College. He became a Fellow of the Royal Society in 1949 and was Scientific Adviser to the Army Council in 1951.

REFLOATING OF S. S. "HEBBLE."—During the gales of January 31st the breaching of the banks of the River Humber caused flood water to enter the Immingham Docks and this knocked away the supports of the "Hebble," so that it rolled on its side and was submerged. The plans devised by the Humber Graving Dock and Engineering Company to right the vessel entailed mounting four steel pillars to the hull, from each of which a steel rope passed through a series of pulleys and was attached to a single steel rope. This extended to the railway sidings and was attached to two 0-4 engines capable of exerting a pull of 6 tons, which by the mechanical advantage of the pulleys was increased to 14 tons. To maintain control of the pull of the locomotives an indicator dial was mounted on a truck, behind the tender of the first engine, together with mirrors to enable the dial to be read from the footplate. A control centre was established at the end of the dry dock and communication was maintained with the operator on the locomotives, which were out of sight, by walkie-talkie radio. During the righting operations, which occupied about thirty minutes, the engines exerted a steady pull and their movements were synchronised with the gradual admission of water into the dry dock.

Miscellanea

NEW IMPLEMENTS AT THE ROYAL SHOW.—The Royal Agricultural Society says that from fifty entries of new implements for silver medal awards, ten have been accepted for adjudication provided a test report of each is available before the Royal Show at Blackpool in July. The entries will be judged with six others which were deferred from last year's Royal Show. This year's judges for new implements are Mr. A. Herbert Carter, Major T. K. Jeans, and Mr. Leslie Langmead.

BRUSH-ABOE GROUP'S TECHNICAL JOURNAL.—We have received from the Brush-Aboe group of companies a copy of the group's new technical journal, which will appear every two months. The journal contains information about the various member firms of the group and about recent installations supplied by the individual companies. In addition to articles of general interest there are a number of technical articles dealing with such subjects as the use of detergent lubricating oils, oil engine crankshaft inspection, closing mechanism for large circuit breakers, air swirl in diesel engines, and the harmonic balancing system.

MIDDLESBROUGH DOCK IMPROVEMENT SCHEME.—The Docks and Inland Waterways Executive is to undertake an improvement scheme at Middlesbrough Dock at an estimated cost of £470,000. The No. 10 Quay, which has hitherto been used exclusively for shipping coal, is to be developed for general cargo working by the provision of two single-storey transit sheds, respectively 385ft and 350ft long, eight 6-ton and two 10-ton level-luffing electric cranes and ample rail and road access. The scheme also provides for improved facilities, including a new road, at No. 2 Quay. The start of this work is subject to the approval of the Minister of Transport, it is stated.

EXPERIMENTAL TELEVISION TRANSMITTER.—Speaking at the annual dinner of the Television Society on Monday last, Sir Robert Renwick, the president, said that the Society proposed to build shortly an experimental 625-line transmitter to provide a service both to amateurs and the radio industry. It was, Sir Robert explained, an experimental project undertaken for the advancement of television technique, subject to Post Office approval, and would transmit still pictures for experimental purposes. The Society would take advice from the B.B.C. and the radio industry and it was hoped that the export trade would benefit accordingly.

VENT-AXIA FANS, LTD.—At the Junior Carlton Club, in London, on Wednesday of last week, April 8th, a very pleasant function took place. It was a luncheon party to welcome the appointment of Admiral Sir Wilfred Paterson to the Board of Vent-Axia Fans, Ltd. Mr. J. C. Akester, chairman of the company, took the chair. As might have been expected, the affair had pronouncedly a naval flavour. Amongst those present to congratulate Admiral Sir Wilfred Paterson were Admiral of the Fleet Lord Fraser, Lord Webb Johnson, Vice-Admiral Kelsey and Rear-Admiral Dietrich of the American Navy. Many personal friends as well as representatives of the firm were present.

BRAKE PRESSURE WARNING UNIT.—To indicate failure or partial failure of pneumatic braking systems in vehicles, Bosch, Ltd., of 45, South Audley Street, London W.1, has developed a mechanical warning device. It consists of a small aluminium compressed air cylinder enclosing a plunger, which communicates with the pneumatic system and carries a toothed rack. The rack engages with a pinion integral with a pointer 14in long. The unit, which weighs about ¼ lb, is normally mounted on the windscreen frame with the pointer lying horizontal. Should the air pressure commence to fall from about 56 lb per square inch the pointer rotates and with pressures below 42 lb per square inch it remains vertical.

FLUID COUPLINGS.—A brochure has been published by the Fluidrive Engineering Company, Ltd. (formerly the Hydraulic Coupling and Engineering Company, Ltd.), of Worton Road, Isleworth, Middlesex, tracing the origin, development and history of the hydraulic coupling. In a series of concise notes under the title of "The Romance of Fluidrive," Mr. Harold Sinclair presents the main events in the increasing use of the hydraulic coupling from its conception by Dr. Herman Föttinger in 1905 up to the present wide use of the Vulcan-Sinclair coupling. An illustrated article by Dr. G. Bauer then deals in detail with "The Origin and Development of the Föttinger Transformer, Vulcan Coupling and Vulcan Gear."

NEW SHOWROOM AT HEENAN AND FROUDE WORKS.—A permanent showroom for the display of automatic machines has been opened at its Worcester factory by Heenan and Froude, Ltd. This showroom, which has been built primarily for visitors to the United Kingdom, will have a full range of automatics installed in time to demonstrate their applications to overseas visitors who will be in this country for the British Industries Fair. The equipment shown will include a ring coiling machine, a fence staple-making machine, a paper clip machine, chain-making machines, nail presses, a straightening and cutting machine, wireforming machines tooled up for different jobs, strip-forming machines, and a nail cutter grinding machine.

COAL OUTPUT.—Last week's coal production figures showed the effect of the Easter holiday period. Saleable output from the deep mines was 3,193,800 tons, and from opencast workings 168,900 tons, giving a total for the week of 3,362,700 tons. In the preceding week—which included part of the Easter holiday—total output was 4,060,300 tons. In the first fourteen weeks of this year the saleable output of coal, deep-mined and opencast, totalled 62,722,400 tons, compared with 63,727,200 tons in the corresponding period of last year. As, however, part of the Easter holiday last year fell in the fifteenth week, the figures are not strictly comparable. Total coal consumption, home and export, took up 4,399,000 tons in the week ended April 4th, compared with 4,667,000 tons in the corresponding week of 1952. On April 4th this year distributed stocks amounted to 12,698,000 tons, compared with 13,202,000 tons on the corresponding date last year.

HARBOUR IMPROVEMENTS IN NORTHERN IRELAND.—Substantial progress is being made in the improvement of harbours in Northern Ireland. Londonderry Harbour Commissioners recently placed a contract for the carrying out of a major improvement scheme at that port, including the reconstruction of an existing wharf, the construction of a new extension wharf, and the provision of storage sheds; it is estimated to cost approximately £250,000 and to take some three years to complete. A scheme for the improvement of Coleraine Harbour has also been approved, estimated to cost £33,000. The fishery harbours at Kilkeel and Portavogie (County Down) are being improved. A tender for £201,000 for the carrying out of the proposed works at Portavogie was accepted in June last; the work will take some two years to complete. For Kilkeel tenders have been invited for the carrying out of the first stage of the scheme, which includes the deepening of the entrance channel, the strengthening of the piers, &c., and is estimated to cost approximately £100,000. The Government is continuing to encourage harbour authorities generally to undertake works of major improvement and to provide modern facilities for the handling of traffic. Schemes at Newry and Larne Harbours will continue during the present year.

SAFETY IN THE USE OF POWER PRESSES.—The Second Report of the Joint Standing Committee on Safety in the Use of Power Presses published by the Factory Department of the Ministry of Labour and National Service, records the work accomplished since the publication of the Committee's first report in 1950. It is stated that experience with the use of guards recommended by the Committee in its first report has shown the need for some revision, modification or extension of their principles. Consideration has been given to additional devices for preventing uncovenanted strokes of the machine when an interlock guard is in the open position. Proposals have been agreed with the British Power Press Manufacturers' Association for incorporating in the design of new presses certain measures enabling the fitting of a safety device and for the design of safer clutch extractors. Means of preventing undue wear on the mechanism of interlock guards caused by excessive pressure on pedals and hand-controlled levers which interfere with the functional work of the guard, have been investigated, and the committee advocates the use of sequential operating guards, which have the added advantage of facilitating improved production rates.

Personal and Business

VISCOUNT CALDECOTE has joined the board of the English Electric Company, Ltd.

SIR ARCHIBALD ROWLANDS has joined the board of Henry Simon (Holdings), Ltd., Cheadle Heath, Stockport.

MR. F. V. PEARSON has been appointed general manager of Vandome and Hart, Ltd., North London Ironworks, Wenlock Road, N.1.

MR. WILFRED SAMPSON, A.M.I.E.E., has been appointed commercial manager of Telcon Telecommunications, Ltd., Greenwich, S.E.10.

MR. W. G. ARDLEY, joint managing director of George Kent, Ltd., Luton, has been elected to honorary membership of the Institution of Water Engineers.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that its overseas reception office has been transferred to 11, Bedford Square, London, W.C.1 (telephone, Museum 1600).

MR. C. L. G. FAIRFIELD, M.I.E.E., has been appointed manager of the overseas division of the Telegraph Construction and Maintenance Company, Ltd., Greenwich, S.E.10.

THE BRITISH ELECTRICITY AUTHORITY announces the retirement, at the end of this month, of Mr. T. H. Wood, M.I.Mech.E., chief generation engineer (construction), South Wales Division.

MR. A. H. CARMICHAEL has been appointed director of the Cable Makers Association. He succeeds Sir John Dalton, who has now become chairman of W. T. Henley's Telegraph Works Company, Ltd.

THE P. D. N. CASTLE ENGINEERING COMPANY, Ltd., informs us that it has moved its offices from 87, Pembury Road, Tottenham, to Yeovil Works, Lea Road, Waltham Abbey, Essex (telephone, Waltham Cross 4311).

THE DUNLOP RUBBER COMPANY, Ltd., states that Mr. J. R. English, manager of the tube department at the Speke factory, has been appointed assistant production manager of the Dunlop factory at Kobe, Japan.

DR. L. C. TYTE has been appointed director of the National Coal Board's second central research establishment at Isleworth, Middlesex, which is engaged on investigations into the coal mining industry's underground problems.

DR. DENIS REBBECK has been appointed deputy managing director of Harland and Wolff, Ltd., Belfast. Mr. H. C. McEwan, electrical manager, and Mr. W. H. Park, shipyard manager, have been appointed directors of the company.

MR. R. S. ATKINSON, A.M.I.Mech.E., has been appointed chief generation engineer (operation) in the Merseyside and North Wales Division of the British Electricity Authority, in succession to Mr. R. L. Batley, who is now controller of the Midlands division.

THE CANADIAN PACIFIC RAILWAY has announced the appointment of Mr. F. A. Benger as chief of motive power and rolling stock in succession to the late Mr. W. A. Newman. Mr. Benger, who joined the C.P.R. in 1913, has been assistant chief of his department since 1948.

MR. G. C. D. RUSSELL has been appointed assistant managing director of Handley Page, Ltd., and of its subsidiary, Handley Page (Reading), Ltd., and Mr. J. H. S. Green has been appointed secretary of both companies. Mr. G. R. Volkert has been appointed technical director of Handley Page (Reading), Ltd.

R. AND W. HAWTHORN, LESLIE AND CO., Ltd., St. Peter's Works, Newcastle upon Tyne, states that Sir Philip Johnson is relinquishing the office of managing director on April 30th. He will continue as deputy chairman of the company. Mr. John Bulman is to be appointed managing director and Mr. D. G. Ogilvie, at present works manager, is to become general manager.

SHELL-MEX AND B.P., Ltd., states that Mr. D. B. Cousar has been appointed aviation manager of Scottish Oils and Shell-Mex and B.P., Ltd., and of Shell-Mex and B.P. northern division. Mr. C. E. Massey, Mr. G. Murray, and Mr. R. T. R. Poulton have been appointed aviation managers in the north-western and north-eastern, western and eastern and midland divisions respectively. Mr. R. G. Woodman has been appointed aviation supervisor in the southern division and Mr. H. R. Gardner continues as aviation manager in the London division.

British Patent Specifications

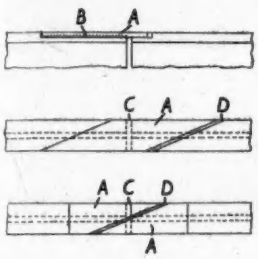
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgement is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2 2s. 8d. each.

RAILWAY ENGINEERING

688,456. September 1, 1951.—RAILWAY RAIL JOINTS, Stanley Gregory, 41, Gipsy Lane, Nuneaton, Warwickshire.

The invention refers to a method of joining railway rails. From the drawings in which the fishplates have been omitted, as they are not affected, it will be seen that a section of metal *A* is inserted into the top flange of the rail, symmetrically about the butt joint of two adjacent lengths of rail to a depth of approximately one-half the thickness of the flange, as shown in the upper view. In the first design, shown in the centre view, the metal insertion is at an oblique angle to the



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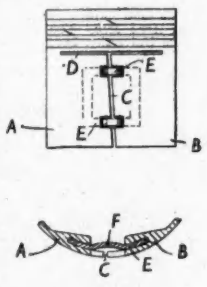
longitudinal axis of the rail and it is welded to one length of rail on the edges of the flange, as at *B*. In the second design, shown in the lower view, the metal insertion is of rectangular form, bisected obliquely to the longitudinal axis of the rail, each resultant half being welded to its respective length of rail on the edges of the flange. The amount of expansion gap prevailing at the butt joint *C* is maintained in linear direction *D* at the splayed joint introduced by the insertion. This invention concerns rails already laid and in no way entails any alteration to the existing method of cutting the ends of rails prior to laying.—*March* 4, 1953.

INTERNAL COMBUSTION ENGINES

688,568. October 27, 1950.—PISTONS FOR INTERNAL COMBUSTION ENGINES, Alan Hawker Chamberlain, Salmon Street, Port Melbourne, Victoria, Australia.

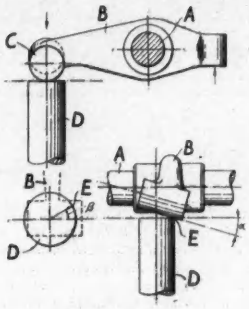
As the drawings show, the piston has skirt portions *A* and *B* on opposite sides of a longitudinal slot *C* between the open end of the piston, and a partly circumferential slot *D* terminating at the upper end. The skirt is relatively thin and flexible, and in response to forces applied in directions at right angles to the slot *C* the skirt portions *A* and *B* tend to be expanded by thrusting forces and contracted by retractive forces. In order that the skirt portions may be readily expanded or contracted, strips of mild steel *E* bridging the slot *C* are mounted in the skirt portions. The strips are fixed at the required distance from the open end of the piston and the partially circumferential slot *D* and the ends are embedded in the skirt during the casting process. Various designs are shown in the specification and the tool used for spreading or contracting the skirt by bending the steel strips is also described and illustrated.—*March* 11, 1953.



No. 688,568

688,597. May 8, 1951.—DEVICE FOR ROTATING OVERHEAD VALVES, Fiat Societa per Azioni, 300 Corso IV Novembre, Turin, Italy.

The invention relates to a device for rotating about their axis the valves of overhead valve internal combustion engines during engine operation. It is particularly suitable for high-speed engines to improve the life of exhaust valves. A pivot *A* carries a rocker arm *B* having an end *C* in the form of a cylindrical head co-operating with a valve stem *D*. The cylinder in contact with the end of the stem of the valve forms an acute angle, the cylindrical head *C* being arranged in such manner that the plane defined by the point of contact *E* with the end of the valve stem is in no case perpendicular to the axis of oscillation of the rocker arm *B*. In this way the vector radius of the contact point *E* of the generatrices of the head *C* with the end of the valve stem *D* forms, with a line parallel with the axis of oscillation of the rocker arm, an angle, the maximum value of which is constantly less than



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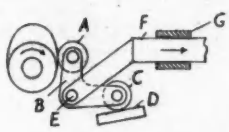
90 deg. During the operative stroke of the rocker arm *B* a force is applied to the point *E* having a tangential component which, owing to the friction between the head *C* and stem *D*, is transmitted to the stem to rotate the valve about its axis.—*March* 11, 1953.

POWER TRANSMISSION

688,478. February 2, 1950.—MEANS FOR TRANSMITTING MOTION, David Brown and Sons (Huddersfield), Ltd., Park Works, Lockwood, Huddersfield, and William Alfred Tuplin, also of the company's address.

The invention relates to means for transmitting motion whereby uniform rotation of a shaft can be caused to effect linear motion, not necessarily uniform, to a member constrained to move between parallel



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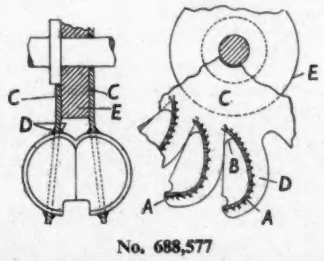
guides. Referring to the drawing, a shaft carrying a cam acts through a roller *A* upon one arm of a pivoted bell crank lever *B*, the other arm of which carries a roller *C* which traverses a fixed plane adjustable surface *D*. The pivot *E* of the lever *B* is connected to the part *F* moving within parallel guides *G*. As the cam rotates it tends to rock the lever *B* about its pivot *E*. If the control surface *D* is parallel to the planes of the guides *G* the lever and the part *F* move as if integral with one another at a velocity determined by the angular velocity of the driving shaft and the shape of the cam. If, however, the control surface is, as shown, inclined with respect to the direction of movement to the part *F*, the lever *B* is moved pivotally as the cam rotates, and the ratio between the angular velocity of the driving shaft and the linear velocity imparted to the part *F* will be varied. By varying the shape of the cam and/or by appropriately contouring the control surface, further changes in the rate of linear movement imparted to the part may be made. Modified designs of this mechanism are shown in the specification.—*March* 11, 1953.

WATER TURBINES

688,577. December 1, 1950.—HYDRAULIC TURBINES, The English Electric Company, Ltd., Queens House, 28, Kingsway, London, W.C.2 (*Inventor: Paul Deriaz*).

The invention provides improvements in turbine buckets and fixing them to runner wheel discs. The drawing shows a Pelton runner wheel made according to the invention. The twin bucket shells *A* are fitted



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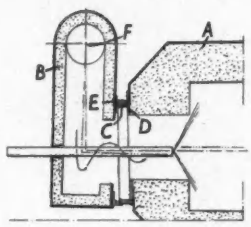
into cut-outs *B* of steel plates *C*, following the contour of the cross section of the shells approximately at their largest radial dimensions, and connected to them by long weld seams *D*. The plates *C* form part of the runner disc *E* of the Pelton wheel and are assembled by welding or bolting. From the drawing it will be seen that the line of intersection of the plates *C* with the buckets *B* is at or near the largest radial or substantially radial dimension of the buckets to ensure a maximum length of the weld seam. Modified designs are also shown in the specification.—*March* 11, 1953.

FURNACES

688,240. April 16, 1951.—JOINTS FOR ROTARY FURNACES, Paul Blanchard, 6, rue Say, Paris, 9°, France.

The object of the invention is to provide a gas-tight joint for a rotary furnace. Referring to the drawing, it will be seen that the joint between the furnace chamber *A* and the burner mounting *B* is formed by a ring *C* with two bearing surfaces, one plane which bears against a surface *D* on the furnace chamber and is substantially perpendicular to its axis and that of the ring, which bears against a corresponding spherical bearing surface on a part *E* fixed to the burner mounting. The mounting, which



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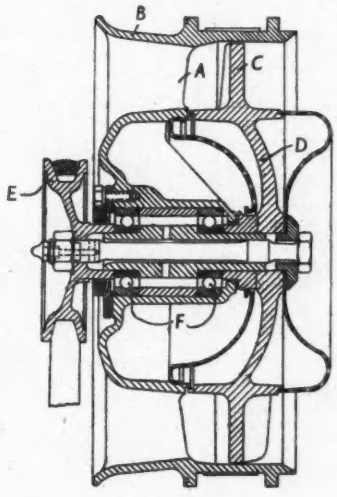
is removable from the furnace chamber is maintained, in the operative position, pressed against the plane face of the furnace by any suitable means. The gas tightness of the joint is not affected by any departure of the actual axis of rotation from the theoretical axis of rotation of the various parts of the furnace. The burner mounting can pivot about an axis *F*, so that it can be moved away from the furnace chamber for placing the ring *A* in position or for removing it. Alternative designs of concave reinforced and spring-controlled joints are also shown in the specification.—*March* 4, 1953.

COMPRESSORS AND BLOWERS

689,073. February 16, 1951.—ROTARY BLOWERS, Klockner-Humboldt-Deutz, Aktiengesellschaft, Deutz-Mulheimerstrasse 149/155, Cologne, Germany.

The drawing shows an axial blower in which guide blades *A* mounted in the housing *B* are provided in front of the blades *C* of the rotor *D*. The rotor is driven through a belt pulley *E*. The pulley and the rotor are mounted in the housing on roller bearings *F*.



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The rotating parts of the blower are held tightly together by a screw arranged on their longitudinal axis, so that they drive one another by frictional contact alone. A lubricator is mounted on the front end of the screw which is bored so that lubricant can penetrate the interior and flow through bores in the sleeve to the roller bearings. The specification also shows the rotating parts of a Roots blower frictionally connected in the same way as already described.—*March* 18, 1953.

Launches and Trial Trips

SHERATAN, oil tanker; built by the Netherlands Dock and Shipbuilding Company for N.V. van Nievelt Gondriaan and Co.; length between perpendiculars 532ft 6in, breadth moulded 72ft 9in, depth 38ft 3in, draught loaded 29ft 6in; speed 15·25 knots; deadweight 18,500 tons; Stork double-acting, two-stroke, diesel engine, seven cylinders, 7500 b.h.p. at 118 r.p.m.; two 200kW diesel-driven generators, one 120kW steam driven generator, two Scotch boilers. Launch, March 21st.

LEDA, passenger liner; built by Swan, Hunter and Wigham Richardson, Ltd., for the Det Bergenske Dampskibsselskab. of Bergen; length between perpendiculars 410ft, breadth moulded 57ft, depth moulded to upper deck 30ft, deadweight 1970 tons in 20ft draught, service speed 21 knots; three cargo holds, MacGregor steel hatch covers, Denny-Brown stabilisers, 119 first-class and 384 tourist-class passengers; two sets of Wallsend Slipway double reduction geared turbines, 13,000 s.h.p. at 150 r.p.m. of the propeller, steam supplied at 450 lb per square inch and 800 deg. Fah. by two Babcock and Wilcox boilers, three 350kW Brotherhood turbo-generators. Trial, March 31st.

BURMAH SAPPHIRE, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the Burmah Oil Company (Tankers), Ltd.; length between perpendiculars 409ft 6in, breadth moulded 56ft, depth moulded 31ft 3in, load draught 25ft 2¼in, deadweight 8510 tons, service speed 12 knots; Wallsend-Doxford two-stroke oil engine, four cylinders 600mm bore by 2320mm combined stroke, 3500 b.h.p. at 109 r.p.m., two multi-tubular Scotch boilers. Launch, April 1st.

MAID OF SKELMORLIE, passenger ferry; built by A. and J. Inglis, Ltd., for British Railways (Scottish Region); length overall 165ft, breadth moulded 28ft, depth moulded 10ft, displacement 420 tons; 650 passengers; two sets of British Polar " M.461 " diesel engines; service speed 15 knots. Launch, April 2nd.

WAIMEA, cargo liner; built by Alexander Stephen and Sons, Ltd., for the Union Steam Ship Company of New Zealand, Ltd.; length 325ft, breadth 50ft, depth 26ft, deadweight 5100 tons, MacGregor steel hatch covers, Clarke Chapman electric cargo winches; Stephen-Sulzer single-acting diesel engine, six cylinders, 600mm diameter by 1040mm stroke, 2410 b.h.p. at 128 r.p.m., service speed 12 knots; three 135kW Ruston and Hornsby diesel-driven generators. Trial, April.

BEAUCE, oil tanker; built by the Ateliers et Chantiers de la Seine Maritime for the Société Francaise des Transports Pétroliers; length between perpendiculars 519ft 11in, breadth moulded 67ft 6in, depth 38ft 10½in draught 30ft 2in, deadweight 17,200 tons, service speed 14 knots; Saint-Nazaire Penhoët-B. and W. two-stroke, single-acting diesel engine, eight cylinders, 740mm diameter by 1400mm stroke, 7000 b.h.p. at 125 r.p.m. Trial, April.

PROMETHEE, cargo liner; built by the Chantiers Navals de Caen for the Société Navale Caennaise; length between perpendiculars 363ft 8in, breadth 49ft 3in, depth to main deck 24ft 8in, deadweight 5600 tons, four holds, MacGregor steel hatch covers; reciprocating steam engine, 1750 h.p. at 115 r.p.m., two cylindrical boilers. Trial, April.

Catalogues

CLAUDE RYE BEARINGS, Fulham Road, London, S.W.6.—Bearing conversion list.

SIMPLEX ELECTRIC COMPANY, Ltd., Oldbury.—Booklet of Lundberg accessories and price list.

FLEXELLO CASTORS AND WHEELS, Ltd., Trading Estate, Slough, Bucks.—Illustrated catalogue of castors and wheels.

CROMPTON PARKINSON, Ltd., Crompton House, Aldwych, London, W.C.2.—Catalogue of educational instruments.

W. G. PYE AND CO., Ltd., Granta Works, Newmarket Road, Cambridge.—Catalogue giving details of scientific instruments.

SUNVIC CONTROLS, Ltd., Sunvic House, 10, Essex Street, Strand, London, W.C.2.—Leaflet entitled " Tools for Every Laboratory."

TANGYES, Ltd., Cornwall Works, Smethwick, Birmingham.—List No. 731B, describing lightweight, heavy duty hydraulic jacks.

WESTOOL, Ltd., St. Helen's Auckland, Co. Durham.—Leaflet No. 23/52, dealing with d.c. solenoids, Series L, pull and thrust types.

G.W.B. ELECTRIC FURNACES, Ltd., Dibdale Works, Dudley, Worcs.—Catalogue giving details of " Autolec " thermal storage systems.

NON-CORROSIVE METAL PRODUCTS, Yiewsley, Middlesex.—Publication No. 6, illustrating a selection of light alloy marine equipment.

STANDARD TELEPHONES AND CABLES, Ltd., Connaught House, Aldwych, London, W.C.2.—Booklet covering self-contained alarm system.

ENGLISH STEEL CORPORATION, Ltd., Sheffield, 9.—Publication describing various automatic couplers, for railway, mine, quarry and industrial uses.

BAILEY METERS AND CONTROLS, Ltd., Progress Way, Croydon.—Catalogue E1022, dealing with automatic control applied to spreader stoker-fired boilers.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, 17.—Brochure on infra-red equipment, showing Metrovick element projectors.

E. C. PAYTER AND CO., Ltd., Meeting Street, Great Bridge, Tipton, Staffs.—Leaflet entitled " Design and Fabrication in Aluminium and Aluminium Alloys."

NORTHEY ROTARY COMPRESSORS, Ltd., 200–202, Alder Road, Parkstone, Dorset.—Catalogue containing leaflets covering oil-free compressors and vacuum pumps.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publication No. 9701, illustrating and describing rotary dryers and coolers.

ABINGDON KING DICK, Ltd., Abingdon Works Kings Road, Tyseley, Birmingham.—Illustrated hand tool reference book containing information on the new hexagon nut and bolt sizes.

BABCOCK AND WILCOX, Ltd., Babcock House, Farringdon Street, London, E.C.4.—Publications Nos. 1542, 1543 and 1544, illustrating and describing Babcock stokers, styles 6, 28 and 133

MONOMETER MANUFACTURING COMPANY, Ltd., Savoy House, 115–116, Strand, London, W.C.2.—Brochure describing the " Monometer " fully mechanised oil or gas-fired hot metal receivers, as used in the ironfoundry.

FIELDEN (ELECTRONICS), Ltd., Wythenshawe, Manchester.—Leaflets giving details of an electronic thermostat and a precision manually operated temperature resistance bridge. Folder describing an electronic resistance bulb multipoint thermometer.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CHEMICAL SOCIETY

Thurs., April 30th.—Burlington House, Piccadilly, London, W.1, " The Scientific Problems of Surface Catalysis," H. S. Taylor, 7.30 p.m.

ENGINEERS' GUILD

Thurs., April 23rd.—ORDINARY MEETING: Caxton Hall, Westminster, London, S.W.1, Discussion on " Freedom in Engineering," A. Floyd, 6 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Fri., April 24th.—Church Institute, Albion Street, Hull, Annual General Meeting, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

To-day, April 17th.—BIRMINGHAM CENTRE: " Regent House," St. Philip's Place, Colmore Row, Birmingham, " Discharge Lamps for Particular Purposes," E. H. Nelson, 6 p.m.
Tues., April 21st.—LIVERPOOL CENTRE: Merseyside and N. Wales Electricity Board's Service Centre, Whitechapel, Liverpool, 1, " Shop Window Lighting," A. W. Jervis, 6 p.m.

INCORPORATED PLANT ENGINEERS

Mon., April 20th.—LIVERPOOL AND N. WALES BRANCH: Radiant House, Bold Street, Liverpool, " The Engineer and the Brewing Industry," G. W. Campbell, 7.15 p.m.
Tues., April 21st.—GLASGOW BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, Film, " Mobile Mechanical Handling Plant," 7 p.m.——HERTFORDSHIRE DISCUSSION GROUP: Peahen Hotel, St. Albans, " Industrial Lighting," W. S. Veness, 7.30 p.m.
Fri. April 24th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, " The Approach to Maintenance," H. G. Hilton, 7.30 p.m.
Thurs., April 30th.—S. YORKSHIRE BRANCH: Grand Hotel, Sheffield, Film and Discussion on the Making of Glass, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues, April 21st.—EAST ANGLIAN SECTION: Central Hall, Public Library, Ipswich, Annual General Meeting, 7 p.m.
Wed., April 22nd.—BIRMINGHAM BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting, " The Production of Match Plates by the Aluminium Pressure Cast Method," D. H. Potts, 7.15 p.m.
Wed., April 29th.—LONDON BRANCH: Waldorf Hotel, London, W.C.2, Annual General Meeting, followed by Films, " New Methods for Old " and " Avec Le Feu Sacré," 7 p.m.

INSTITUTE OF ECONOMIC ENGINEERING

To-day, April 17th.—George Hotel, Church Lane, Kingsbury, London, N.W.9, " How Big is Too Big ? " A. W. Willsmore, 7 p.m.

INSTITUTE OF FUEL

Tues., April 28th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, " Refractory Recuperators," A. L. Roberts, 5 p.m.

INSTITUTE OF MARINE ENGINEERS

Fri., April 24th.—JOINT MEETING WITH THE BARROW ASSOCIATION OF ENGINEERS: Technical College, Barrow-in-Furness, " Ships that Serve Ships," T. Clark, 7.30 p.m.

INSTITUTE OF NAVIGATION

To-day, April 17th.—Royal Geographical Society, 1, Kensington Gore, London. S.W.7, " The Use of Radar for Preventing Collisions at Sea," F. J. Wylie, 5 p.m.

INSTITUTE OF PETROLEUM

Tues., April 21st.—26, Portland Place, London, W.1, Presidential Address, " Two Oilfields in Northern Iraq," H. S. Gibson, 6 p.m.
Wed., April 22nd.—Institution of Mechanical Engineers Storey's Gate St. James's Park, London, S.W.1, " Engine Testing of Lubricating Oils," Symposium organised by R. Stansfield, 2.30 p.m.

INSTITUTE OF REFRIGERATION

Tues., April 21st.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, " An Analysis of the Factors Affecting Performance of Small Compressors," W. B. Gosney, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., April 21st.—EASTERN CENTRE: Marshalls Airport, Cambridge, Annual General Meeting, 7 p.m.
Thurs., April 23rd.—LONDON CENTRE: Royal Society of Arts, John Adam Street, London, W.C.2, " The Wilson Gearbox in the Field of Commercial Transport," A. Gordon Wilson and A. A. Miller, 7.15 p.m.
Mon., April 27th.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting, 7.30 p.m.
Tues., April 28th.—N.E. OF ENGLAND GROUP: Royal County Hotel, Durham City, Annual General Meeting, followed by Film Show 7 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Tues., April 21st.—INFORMAL MEETING: Institution of Electrical Engineers, Savoy Place, London, W.C.2, " Farm Transport, Including Loading and Unloading," 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

To-day, April 17th.—GRADUATES' AND STUDENTS' SECTION: University College, Gower Street, London, W.C.1, " Symposium on Effluent Disposal," 9.30 a.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 21st.—ORDINARY MEETING: Great George Street, Westminster, London, S.W.1, " The Preservation of Timber," N. A. Richardson, 5.30 p.m.
Tues., April 21st.—YORKSHIRE ASSOCIATION: Chemistry Lecture Theatre, The University, Leeds, " Effects of Ground Vibrations Due to Piling and Large Forging Hammers," L. Bendel, 6.30 p.m.
Thurs., April 23rd.—YORKSHIRE ASSOCIATION: Chemistry Lecture Theatre, The University, Leeds, " Landslides and Stability of Slopes," L. Bendel, 4.30 p.m.; " Settlement Problems in Building," L. Bendel, 7 p.m.——PUBLIC HEALTH MEETING: Great George Street, Westminster, London, S.W.1, " Bacteria in Relation to Water," E. Windle Taylor, 5.30 p.m.
Fri., April 24th.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds, Annual General Meeting, " The Examination, Assessment, Repair, Maintenance, and Renewal of Old Railway Bridges," A. Dean, 7 p.m.
Tues., April 28th.—ROAD MEETING: Great George Street, Westminster, London, S.W.1, " The Design of Motorways," T. E. Hutton, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., April 20th.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on " Laboratory Experiments on Protective Gear," opened by H. P. Young, 6 p.m.
Tues., April 21st.—S.W. SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, " The Stability of Oil in Transformers," P. W. L. Gossling and L. H. Welch; " Inhibited Transformer Oil," W. R. Stoker and C. N. Thompson, 7 p.m.
Wed., April 22nd.—RADIO SECTION: Savoy Place, London, W.C.2, " An Investigation of the Characteristics of Cylindrical Surface Waves," H. M. Barlow and A. E. Karbowiak; " Surface Waves," H. M. Barlow and A. L. Cullen, 5.30 p.m.——S.E. SCOTLAND SUB-CENTRE: Heriot-Watt College, Edinburgh, " The Stability of Oil in Transformers," P. W. L. Gossling and L. H. Welch; " Inhibited Transformer Oil," W. R. Stoker and C. N. Thompson, 7 p.m.
Thurs., April 23rd.—ORDINARY MEETING: Savoy Place, London, W.C.2, " The Dilemma of Lord Kelvin," P. J. Dee, 5.30 p.m.
S.W. AND S.E. SCOTLAND SUB-CENTRES: Central Halls, Edinburgh, Faraday Lecture, " Light from the Dark Ages or the Evolution of Electricity Supply," A. R. Cooper, 7 p.m.
Tues., April 28th.—MEASUREMENTS AND SUPPLY SECTIONS: Savoy Place, London, W.C.2, " Meter Problems and Consumers' Load Characteristics," L. B. S. Golds and P. Schiller, 5.30 p.m.
Wed., April 29th.—SUPPLY SECTION: Savoy Place, London, W.C.2, " An Assessment of the Impregnated Pressure Cable," L. G. Brazier, D. T. Hollingsworth and A. L. Williams, 5.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Mon., April 20th.—Royal Society of Arts, John Adam Street, London, W.C.2, British Productivity Council's Report, " Inspection in Industry," J. Barnett, 6 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., April 29th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Informal Discussion on " Operating Problems on Colonial Railways," 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, April 17th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, James Clayton Lecture, " Materials Handling," J. R. Bright, 5.30 p.m.
Sat., April 18th.—N.W. BRANCH, GRADUATES' SECTION: Engineers' Club, Albert Square, Manchester, Annual General Meeting, " Thermal Insulation of Industrial Plants," A. G. Chdolansky, 2.30 p.m.
Mon., April 20th.—MIDLAND BRANCH, GRADUATES' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting and Chairman's Address, 7 p.m.
Fri., April 24th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, " The Problem of Fuel Oil Ash Deposition in Open-Cycle Gas Turbines," A. T. Bowden, P. Draper and H. Rowling, 5.30 p.m.——SOUTHERN BRANCH: The University, Southampton, Annual General Meeting, followed by a Film Show, " Britain Awakes," 7 p.m.
Sat., April 25th.—YORKSHIRE BRANCH, GRADUATES' SECTION: The University, Leeds, Annual General Meeting, " Memories of Men, Machines and Materials," E. C. White, 2.30 p.m.
Tues., April 28th.—E. MIDLANDS BRANCH: Technical College, Lincoln, Annual General Meeting, 7.15 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., April 22nd.—INFORMAL MEETING: Conference Room, Fourth Floor, Waterloo Bridge House, London, S.E.1, " Reorganisation—The First Five Years from an Area Angle," F. E. Plumpton and L. W. Rapkin, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., April 20th.—DERBY SECTION: College of Art, Green Lane, Derby, " Textile Engineering," C. E. Roper, 7 p.m.——MANCHESTER SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, 1, " The Machine Tool Industry," W. J. Morgan, 7.15 p.m.——N.E. SECTION: Technical College, Enfield Durham Road, Gateshead upon Tyne, Annual General Meeting, followed by an Inspection of the New Engineering and Laboratory Wing, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Fri., April 24th.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, " Reinforced Concrete Foundations and Structures for Blast-furnaces and Materials and Handling Plant at Shotton, near Chester," O. W. Jones, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, April 17th.—INFORMAL MEETING: Townsend House, Greycoat Place, London, S.W.1, " Graphic Reproduction," J. F. Trusty, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, April 17th.—Mining Institute, Newcastle upon Tyne, " The Development of Modern Naval Machinery and the Consequent Maintenance Problem," A. Funge Smith, 6.15 p.m.
Fri., April 24th.—Mining Institute, Neville Hall, Newcastle upon Tyne, " The Use of Heavy Fuels in Diesel Engines of Marine Auxiliary Sizes," J. Smith, 6.15 p.m.

WOMEN'S ENGINEERING SOCIETY

Mon., April 20th.—LONDON BRANCH: 35, Grosvenor Place, London, S.W.1, " Design of Water-Tube Boilers," Miss J. E. Gardiner, 6.30 p.m.